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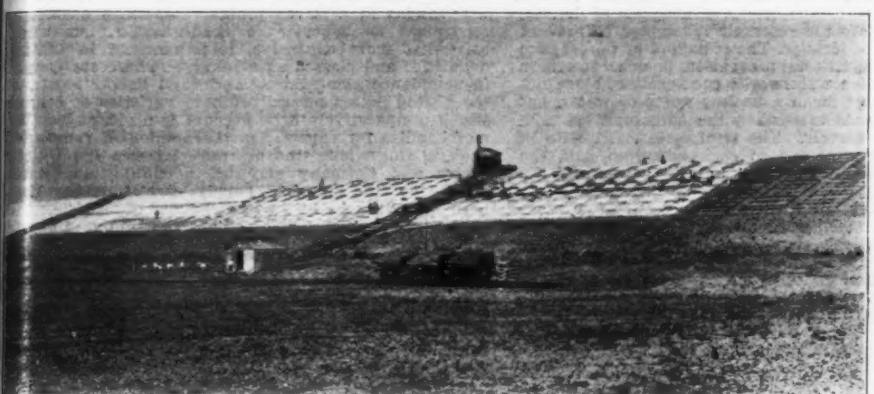
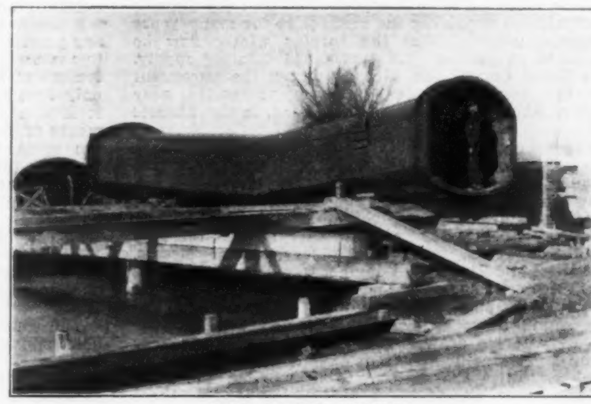
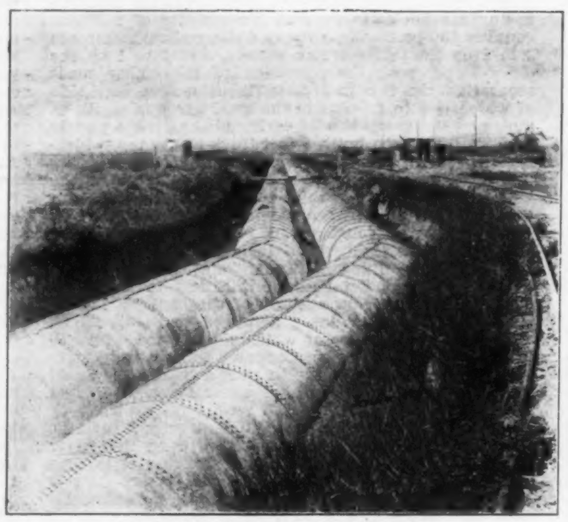


BED OF RESERVOIR, SHOWING CONCRETE SLABS.



NORTH TUBE SIPHON.

IEW WITHIN THE TUNNEL UNDER THE RAILROAD.



THE 6-FOOT 4-INCH STEEL MAINS.

STONEY SLUICE NEAR BILLET BRIDGE.

A BATTERY OF FIVE HORIZONTAL TRIPLE-EXPANSION WORTHINGTON PUMPING ENGINES, EACH HAVING A CAPACITY OF 16,500,000 GALLONS PER DAY.

THE NEW WATER SUPPLY FOR LONDON.

THE NEW AUGMENTED WATER SUPPLY AND RESERVOIRS FOR LONDON.

By the London Correspondent, Scientific American.

During the past few years one of the most complex problems that has confronted the various water companies of London is the provision of an adequate supply of water to meet the demands of a rapidly increasing population—the present daily consumption approximates on the average 212,000,000 gallons—and also the storing of a sufficiency of water to meet any contingencies that may arise from time to time from various causes.

The years 1884, 1887, 1890 and 1891 having been years of considerable drought, and the flow of the Thames, which on the average is 1,350,000,000 gallons per day, during some of the drier summer months having fallen to as low as 333,000,000 gallons per day, it was suggested by the London County Council and others that a new supply should be obtained from Wales or elsewhere. To consider this and other questions a Royal Commission was appointed, and after hearing much evidence it was decided that the Thames is capable of supplying the metropolis for many years to come, provided that the surplus winter flow be stored to supplement the diminished summer supply. The Royal Commission also supported the movement for the construction of immense reservoirs near Staines, about 18 miles west of London, in the Thames Valley.

These water works, built at a cost of $6,250,000, are the largest of their character in the world, and are rapidly approaching completion. One reservoir was filled for the first time on June 26 last. The contract has been undertaken by Sir John Aird & Co., Ltd., the well-known contractors who are carrying out the Nile irrigation works, under the supervision of Messrs. Hunter & Middleton, civil engineers, of Victoria Street, Westminster, London, through whose courtesy we are permitted to publish the following description of the undertaking:

The water is drawn from the River Thames near Windsor at a point known as Bell Weir, by an intake. The companies are entitled to draw from the river 100,000,000 gallons of water per day, so long as there are 400,000,000 gallons of water passing the gage which has already been erected at Peniton Hook, three miles lower down the river. Should there be only 300,000,000 gallons or less than that quantity registered on the gage, the companies are not entitled to draw any water from the river.

At the point of the intake four sluices, a sluice-house and cottage have been constructed. The water from the river is admitted through screens. The outer screens consist of bars of iron placed vertically, and between these and the gates there are five copper strainers, of about seven wires to the inch, to prevent floating matter, leaves, and other objects suspended in the water from passing into the reservoirs. The screens at the intake have to be removed and cleaned twice a day, since the accumulation of flotsam and jetsam is considerable. All operations in connection with the sluice gates are carried out by means of hydraulic machinery.

After the water passes through the sluices from the river it enters an aqueduct, and has to be conveyed for 1¾ miles to the pumping stations. The first length of this conduit is covered for 1,050 feet. The top width of the waterway is about 15 feet, and it carries a depth of 6 feet 4 inches of water. Only a very slight gradient is provided, to enable the water to gravitate to the pumping station—1-100 of a foot in the chain, or 0.8 foot per mile. This gradient is sufficient to permit the passage of 150,000,000 gallons of water per day, or 50 per cent more than is at present required.

The engineers encountered several obstacles in the short distance separating the intake from the reservoirs. Three tributary rivers, two railroads and several public highways had to be crossed. The first obstacle was met 1,050 feet from the intake, when the Colnebrook had to be crossed. This was successfully accomplished by the laying of two immense steel siphons side by side, across the bed of the brook. Two other rivers, the Wyrardisbury and the Colne, had to be crossed in this manner. The longest siphons are under the Wyrardisbury River and are 110 feet from end to end, while there are other siphons 90 feet in length under the River Colne.

The sides and bottom of the aqueduct are built of Portland cement concrete, with expansion joints provided at intervals of 30 feet made of brick laid in asphalt. This precaution is necessary, since the expansion and contraction of concrete is considerable, and the aqueduct would otherwise be ruptured transversely at irregular intervals in its total length. This fact is testified by the play that is exercised upon the joints.

To cross the two railroads that interrupt the aqueduct a double tunnel was bored beneath the railroad embankments. Each tunnel measures 8 feet 3 inches in width by 7 feet 10 inches in height.

The pumping machinery of the pumping station for lifting the water from the aqueduct into the reservoirs, 1¾ miles from the intake, comprises five horizontal triple-expansion, surface-condensing, direct-acting, Worthington pumping engines, arranged side by side as shown in the photograph. Each engine is capable of working independently, and has a lifting capacity of 16,500,000 gallons of water every 24 hours. The height of the lift varies from 4 feet to 43 feet, according to the river level and the height of the water in the reservoirs, special provision on the steam end having been made to meet this great range of work. One pumping engine, however, is held in reserve, so that only four are working simultaneously, making an aggregate throw of 66,000,000 gallons of water per day.

The water flows through a sluice from the aqueduct into five huge wells, each measuring 10 feet long, by 10 feet wide, and 20 feet deep, placed outside the station, one well for each pumping engine. The water is drawn through 60 inlet valves into the air chamber of the pump and forced through another 60 valves into the steel mains leading to the reservoirs. Each pumping engine is double-acting, so that a steady flow of water is assured; and is also tandem in arrangement. The most noticeable feature of this pumping plant is the enormous size of the pumps, as compared with the steam ends, which are of special design for the conditions under which they have to work. Considering the enormous volume of water delivered into the reservoirs every 24 hours, the size of the pumping station is comparatively small, and the Worthington pump, owing to its great economy of space, efficiency, and freedom from breakdown, is almost entirely employed in connection with English waterworks.

The water is delivered into the reservoir through two riveted steel mains, each of which is 6 feet 4 inches in diameter. There are really two reservoirs placed in juxtaposition and separated by an embankment. Under these circumstances, the delivery mains are constructed so that they will discharge the water into either reservoir together or separately.

The mains are carried into the reservoir at a depth of about 50 feet below the surface of the ground by two brick and concrete tunnels, lined with blue brick, which terminate inside each reservoir in an upstand tower—a massive construction of Portland cement concrete faced with blue bricks. This form of delivering the water into the reservoir is adopted to prevent any possibility of leakage. The reduction of the leakage to a minimum, or its total prevention, is a characteristic feature of English waterworks construction, since not only does leakage mean a useless waste of water, but it invariably tends to weaken the dams and embankments of the reservoir. The steel mains terminate in the upstand towers—one to each reservoir—and the water is discharged from the delivery pipes near the ground level.

As already mentioned, there are in reality two reservoirs side by side, with an aggregate capacity of 3,335,000,000 gallons of water. They measure about 1¼ miles in length by five-eighths of a mile wide at the northern end, and nearly a mile wide at the southern end and covering a total area of approximately 421 acres.

The construction of these reservoirs is a commendable engineering feat, since there was no natural depression in the ground, of which the engineers could take advantage to build the basins, but they had to be excavated. The embankments on each side are composed of ballast removed from the basin and vary in height from 21 feet to 39 feet, the excavation just balancing the banks to prevent the expense of material running to spoil. The slopes of the embankments are 3 to 1 on the inside water surface, and 2 to 1 on the outer slope, with the exception of the embankment separating the two reservoirs, the slope on each side of which is 3 to 1. The banks are 14 feet in width at the top. In the middle of each embankment a puddle clay wall has been built, 6 feet thick at the top, widening slowly to 7 feet thick at ground level, and tapering down to 4 feet thick at its lowest level, which is on the London blue clay, into which it is securely toothed at a depth below the surface varying from 9 to 34 feet. This process of construction renders the reservoirs absolutely watertight. The inside slopes of the embankments are lined with concrete slabs 4 feet 3 inches square by 5 inches in thickness to a vertical depth of 20 feet below the top of the bank or 15 feet below the top water level, arranged to break joints, and the lower portions of which are covered with ballast. This system has been adopted to resist any wave action that may take place in such a large expanse of water. The average depth of water is about 30 feet in the first and 32 feet in the second reservoir.

In close proximity to these two reservoirs a basin 50 feet in diameter has been constructed, into which water flows by gravitation from the reservoirs and is thus aerated. A conduit 11 feet in width at the top extends from there to the main aqueduct near the pumping station, and thence to a smaller distributing reservoir at Hampton, 7 miles nearer London. The building of the aqueduct from the main to the auxiliary reservoir was comparatively easy, as it extends through practically open country, and only has to pass beneath main roads and two railroad embankments. The Hampton distributing reservoir has a capacity of 17,000,000 gallons, and the water gravitates the whole distance, either direct from the Thames at Bell Weir, or from the reservoirs, which are only called into action when the supply of water from the Thames is deficient.

The water is discharged from the reservoirs through cast-iron standpipes in the upstand tower of 5 feet internal diameter, with 48-inch and 36-inch sluice valves, with bell mouth bends fitted to them, so that the water may be drawn off at any desired level. The sluice valves are controlled from a platform at the top of each of the water towers, and the gearing is inclosed in a suitable building.

The water is distributed to three companies. The New River Company have their own distributing apparatus near Henworth, but the Grand Junction and the West Middlesex companies draw their supplies from the Hampton reservoir. The apparatus for the purpose is closely similar in each case, consisting of a floating gage made in the shape of a trumpet-mouthed valve pipe fitted with a gunmetal rim. The latter is so adjusted that it slides up and down with the level of the water, on the other part of the pipe. The weight of the bell-mouth is taken by balance weights and copper floats, while to facilitate telescopic motion it is supplied with ball bearings.

When the level of the water changes, the bell mouth rises or falls with it, the depth of water passing over the lip of the bell-mouth weir being regulated by a screw-carrying top fitted to the center of the bell mouth. In this way the quantity of water drawn off by each company can be accurately gaged and regulated. The normal amount of water to be taken by each company is 11,660,000 gallons a day.

SALABLE AMERICAN PRODUCTS FOR GERMANY.

Notwithstanding the industrial depression and commercial disturbances incident to the period of reorganization and adjustment to new conditions through which Germany is now passing, business in many lines, both domestic and foreign, is normally active and healthful. This is particularly true of the trade in food materials and many articles of household utility. As an experienced merchant recently said: "This is a good time to do business in Germany, if one only knows what is really needed and in demand." For the information of American manufacturers and exporters who may be seeking, more or less earnestly, to find a market for their products in this country, the following hints and suggestions, which have been obtained from merchants of standing and experience and confirmed by inquiries received as correspondence at this consulate, are respectfully submitted. Among the articles which appear to be now demanded in Germany, and in which a more or less prosperous export trade to this country can be developed by exporters in the United States who will take the trouble to secure good connections and proceed by correct methods, are the following:

Dried, Smoked, and Salted Fish.—Salmon, halibut, herrings, sturgeons, eels, flounders, sprats, etc., are favorite articles of food in Germany, and as the native supply is always wholly inadequate, they are relatively expensive. Smoked salmon, for example, costs from 20 to 30 cents per pound, and halibut is unknown except as a costly luxury. So inadequate is the supply that there is a large import of fresh fish of common varieties, which are dried, smoked and otherwise cured here, and sold at large profits. American codfish is recognized as superior to Scandinavian, but being somewhat more expensive, it is received in limited quantities and classed as a luxury. There are caught in abundance along the Atlantic and Pacific coasts of the United States several ordinary varieties of fish, of which comparatively little account is made, at least as merchandise for export. In the opinion of competent dealers, this whole line of trade between the United States and Germany may be indefinitely increased. Thus far the foreign supply for Germany has been almost wholly in the hands of Russia, the Netherlands, and Scandinavia, the only imports from our country in 1901 being 539 tons of fresh fish and 859 tons of pickled fish, whereas Great Britain alone sent to this country 22,333 tons of fresh fish, and the whole fish import of Germany was not less than 71,428 tons. The present scarcity and high prices of all kinds of meat give especial emphasis to the demand for fish, and the opportunity thus offered should not be left unimproved. The duty on cured fish is 3 marks (71 cents) per 100 kilogrammes (220 pounds).

Goose Fat.—Another article of prime importance is goose fat, which is used throughout Germany by the working classes as a substitute for butter, both at table and for cooking purposes. Notwithstanding the large production of geese in Germany, the native supply is so inadequate that 6,431,247 live geese were imported last year from Prussia, Austria, and Italy, besides large quantities of dressed geese and goose fat from Poland, Austria-Hungary, and Denmark. The proportions of the trade may be inferred from the fact that one prominent dealer in Berlin is now ready to take from America, or wherever it can be produced in good marketable condition, 200,000 pounds per month, from November to February, both inclusive, of edible goose fat, at the current market rate. This is at present about 20 cents per pound in large wholesale shipments, the import duty being 10 marks ($2.38) per 100 kilogrammes (220 pounds) or approximately 1¼ cents per pound. Proposals, giving price f. o. b. New York or c. i. f. Hamburg or Bremen, sent to the care of this consulate, will be forwarded to the proper address and receive prompt attention.

Paper Bags for Certain Kinds of Merchandise.—In America, sacks or bags made of tough manila paper are used as packages for flour, Portland cement, and various other articles. Germans still pack cement in wooden barrels, which, in consequence of the high cost of wood in this country, are unduly expensive for the value of the material which they are to contain. Paper bags from America were introduced some time ago by one or more German cement factories, and were fully approved, but their further use was prevented because the American makers could not furnish the required sizes or guarantee prompt delivery. If some enterprising maker of manila bags in the United States will take up the business seriously, produce the bags in sizes to contain specified quantities (in kilogrammes) of cement, flour, coffee, etc., and then establish a wholesale depot of his goods in Hamburg, it is practically certain that a large and permanent business could be built up. The duty on such goods is 12 marks ($2.85) per 100 kilogrammes, and double that rate if the bags are cloth lined. All bags destined for Germany must be arranged for metric weights in respect to contents. Such of these bags as are now used here are made principally by English and French firms, who send a traveling salesman once or twice a year to look after their trade.

Insulating Materials for Electrical Appliances.—These, whether in the form of a vegetable fiber, okenite, or various products of caoutchouc, are in large and constant demand in Germany. It is stated by persons familiar with the trade that certain American producers of insulating materials, who sought entrance to the German market, have made the mistake of giving the exclusive sale of their product to one electrical manufacturing company, which would import all it could use itself, but not make any special effort to extend sales among other firms or companies, which are naturally its competitors. It is stated that if American exporters in this line would open a direct wholesale branch in, say, Berlin or Cologne, as the Carborundum Company, at Niagara Falls, has so successfully done, they would secure thereby a large part of the German trade, particularly that of the numerous small electrical manufacturers who do not like to be dependent for any part of their material upon their more powerful competitors, and to resort to cheap, inferior insulating materials of European origin.

Fire Extinguishers.—Extinguishers, which are so universally employed in the United States and Great Britain, have, for some reason, been to a much more limited extent adopted and put into use in Germany. As nearly as can be ascertained, only one extinguisher of any importance is made in this country, and that is said to be of inferior efficiency and at the same time more costly than the best extinguishers made in the United States. The German Postmaster-General has, however, lately given an order for 10,000 such extinguishers, to be used in buildings belonging to that department. This will certainly give a new and definite impetus to the appreciation and use of fire extinguishers in this country, and it is more than probable

that other departments of the government may follow the lead thus taken by the Postmaster-General. These facts are cited to show that this is a favorable time for American makers of fire-extinguishers to introduce and push their goods in this country. Due care should be taken, of course, to protect by patent any special features which are of value; but the special advantages of the American manufacturers will be their long experience, the high and fully established efficiency of their appliances, and the cheapness with which they can be manufactured and put on the market. Fire extinguishers which operate by ejecting a fluid are free of duty; those of other construction are subject to a small duty, not enough to be taken into serious account.

Paper for Newspaper Printing.—If there is any surplus newspaper stock in the United States, there is an open and ready field for it in Germany, where the consumption is steadily increasing and the native supply always rather below local requirements. The duty on imported print paper is $2.38 per 100 kilogrammes, and in order to build up a successful trade in this country, a wholesale depot should be established at Hamburg or Berlin—preferably the former—where a permanent stock should be kept for the supply of newspaper publishers, many of whom, particularly in the smaller cities, would be glad to make contracts for a regular supply. Such a depot should have a clever, active traveling salesman to make a tour of the Empire once or twice a year and work up the trade. It is not probable that much can be done with American print paper through native firms now in the trade, most of whom are interested in European sources of supply, and would consider proposals from America, if at all, only to meet some temporary contingency.

Wood Alcohol and Crude Acetate of Lime.—It is stated that by reason of the failure of the notorious Trebertrocknung Gesellschaft last year, and the consequent disturbance in that branch of manufacture, there is now a scarcity of wood alcohol and crude acetate, the latter of which is used as a convenient vehicle for acetic acid. Both the materials named are largely consumed by the chemical industries of Germany, and, according to the information received at this office, the demand is at present unusually active.

Animal Hair.—There is in Germany a large manufacture of brushes, felt, upholstery, and toys, which consumes vast quantities of bristles and the hair of various wild animals, such as hares, antelopes, deer, etc. A specialty of great importance in this line is the hair used for making wigs, beards, etc., for dolls and mechanical toys, the supply of which now comes mainly from Australasia. There is no duty on these materials, and if there is any available supply of them in the United States, at prices which can compete with those which prevail here, there ought to be in Germany a ready and permanent market. The subject might profitably be investigated on the spot by an expert familiar with qualities, values, and conditions of supply.

Axes and Shovels.—There is in Germany a large and long-established trade in American axes, spades, shovels, mining picks, etc., the superior lightness and efficiency of which are fully understood. But this trade is all in the hands of two large importing firms, who, it is said, maintain an unduly exacting monopoly and charge extravagant prices. In these lines, it is probable that an American drummer could pick up a good many more or less important orders from dealers who have an established trade and would gladly cut loose from their present dependent position and open direct connections for future supplies with independent American manufacturers. The information on which this suggestion is based comes directly from persons concerned in and familiar with the whole economy of the trade, and is believed to be entirely trustworthy.

Oysters.—It is frequently remarked by the large number of Americans who visit Berlin each year, that the oysters supplied here by hotels and restaurants are small, inferior in flavor, and exorbitantly dear. The question is constantly heard, why, with the regular fast steamship service between New York and the two leading German ports, no adequate, systematic effort has been made to supply the large German cities with the superior oysters which are so abundant and relatively cheap in the United States. Without attempting to answer this question or to explain the reasons for existing conditions, the following statement of the more obvious facts pertaining to the oyster trade of Berlin is submitted for the information of those who may be interested in the subject. Oysters are regarded in Berlin as a luxury of the highest class. They are rarely cooked, but are eaten raw in the half shell, as the first course of a formal luncheon or dinner. When served in restaurants, they cost from 50 to 75 cents per dozen. Almost the entire supply is imported from Holland and Great Britain. English "natives" which, like those from Ostend, have the coppery flavor peculiar to most oysters of European origin, cost at wholesale in Germany 140 marks or $33.30 per 1,000—that is, 3 1-3 cents apiece, including import duty, which is 50 marks ($11.90) per 100 kilogrammes (220 pounds). It is said that oysters of good quality are sold at wholesale in the shell at New York and other American ports for about 1 cent each. The commercial problem is, therefore, whether the 2 1-3 cents difference between the wholesale value of an oyster at New York and in Berlin is not enough to cover the cost of packing, freight, and duty and leave a reasonable margin of profit. The subject would seem to be at least worthy of careful examination. It should be understood, however, that Europeans who have never been in America often prefer—or think they do—the coppery bivalves of European waters, and that the many delicious forms of cooked oysters, so highly esteemed in the United States, are practically unknown here and would have to be introduced. The experiment, if feasible at all, would be safest if made with the grades of shell oysters best adapted to being served and eaten raw.

Machine Tools and Machinery.—It is well known that Germany is now passing through a period of industrial depression, and has to a great extent restricted the erection of new manufacturing establishments which during the period from 1898 to 1900, made such large demands on the purveyors of American machinery and tools. It is also true that those imported lathes, planers, milling, and other machines have been used to reproduce themselves and to make many kinds of machinery and tools so excellent in quality and cheap in cost, that Germany has become a self-supplying exporter of many such appliances which were formerly imported from the United States. But while all this is true, there is still a demand in this country for many special forms of machinery and other manufactures of iron, which is only apparent to those directly concerned in that class of trade. From a leading house of this class, whose specialty is the newer forms of American machinery, the following résumé of the more obvious recent demands has been obtained:

In Berlin and its vicinity, there is a call for the most improved machinery for making bolts, screws, rivets, and all that is included under the general category of boiler fittings. One firm will take six sets of such machinery, which must be of the latest and most improved construction. Steam pumps of a capacity to lift about 15,000 gallons per hour, with minimum outlay of power, would also be found salable in this country.

Machines for pressing oil from linseed, rape, sesame, palm, and other oleaginous seeds and nuts, are understood here to be made of high efficiency and relatively cheap in the United States. So far as is known, the American machinery of this class has not been introduced here, and there would seem to be a promising field for it.

German rolling-mill managers now use phosphor bronze, Babbitt metal, and brass for the bearings, as journal boxes of rolls, which, as is well known, are subject to heavy frictional strain when large masses of metal pass between the rolls. It appears that none of the alloys now used for roll bearings are satisfactory, and as a German iron master said recently, "If your people have anything new and better than what we are using, they could sell a shipload of it in Germany."

There are also inquiries for American tool steel, the superior quality of which has been revealed by the vast number of American machine tools and implements now in use here. But there seems to be a difficulty in obtaining a supply, or even quotations, from the makers of such steel in the United States. It is also well known that certain grades of American steel specially adapted for the construction of dynamos and other forms of electrical machinery are superior to anything produced and used for the same purpose here. As long as there was a large export of American electrical machinery to Germany, there would be, of course, no object in offering such materials, but now that this country has become self-supplying in that line, it may be worth while to cultivate and cater to the very tangible demand here for the specially prepared metals which are adapted to such manufacture.

Certain American firms, like the National Cash Register and Columbia Phonograph companies, which are represented here by large and finely appointed branch houses, have attracted great attention by the originality, ingenuity, and attractiveness of certain advertising devices which have been used in their show windows to draw the attention of the passing throng. In general, it may be stated that all such novelties adapted to advertising purposes, which are original and attractive, are in demand and will be found salable in this country. The same is true of many novelties for kitchen and household use, such as paring machines, carpet sweepers, wringers, ice-cream freezers, naphtha stoves, etc.

Among the correspondence received here through the American Machinery Company, of No. 74 Linden Strasse, Berlin, is a letter from a large and important firm in Warsaw, which has branch houses in Moscow, St. Petersburg, Odessa, and other trade centers, and does an extensive business throughout European Russia. The letter specifies in order the classes of machinery and various special kinds of apparatus which are now demanded by their Russian trade, for a supply of which they would gladly receive proposals from American manufacturers and exporters, viz., pumping and hoisting machinery, engines, boring and drilling machines for mines and blast furnaces, stationary and portable steam engines for factory and agricultural purposes, locomobiles and thrashing machines, gas motors, power pumps, equipment for grain elevators, slaughterhouses, and steam laundries, complete apparatus for creameries and the manufacture of butter and cheese, steam heating and ventilating appliances, locomotives for small auxiliary railways, and wagons with automatic discharging devices for loads of grain, seeds, and other finely divided materials. Catalogues, circulars, or proposals concerning any of the above classes of merchandise will, if received here, be forwarded to where they will receive due attention.

Shoes.—Finally, there is the American shoe, which, having been fully introduced and properly handled, continues to gain ground in popular appreciation and steadily increasing sale. It has been stated in these reports * that at the beginning of April, 1901, there was opened at the junction of the principal retail streets of Berlin a large, handsome American shoe store, furnished and equipped throughout on the most approved American plan. Experienced salesmen, competent in German and English—even a colored bootblack from lower Broadway—were brought over to practise and teach American methods of conducting a retail shoe business. Two well-known brands of American-made shoes—one for women, the other for men—have been sold in all sizes, qualities, and styles, at a uniform price of 18 marks ($4.28) per pair. Although costly as regards rent and general running expenses, the store has been from the day of its opening so profitable that the same firm opened last spring a precisely similar establishment at Frankfort, and on October 15, this year, a third one at Hamburg, both of which latter have been, like the first, immediately successful. This pioneer firm, having the whole German field to choose from, naturally selected three of the most promising cities, but there remain Cologne, Leipzig, Stuttgart, Strasburg, Munich, Dresden, and Breslau, all large progressive cities, where, from all that can be inferred, the same enterprise, if properly managed, might be successfully repeated. American shoes are also more or less generally sold by the more prominent and enterprising German retailers; but, as has been often explained, the only way to insure entire and certain success is to keep the business, from factory to final distribution, as nearly as practicable, in American hands.

It need hardly be repeated that in all the foregoing suggestions, whether relating to dried fish, fire extinguishers, goose fat, or machinery, the point should always be kept in mind to make everything as plain and easy as possible for the buyer. Americans seem generally unable to realize that a nation which aspires to do a large export trade must, as a rule, deliver its goods in the country where they are to be sold and consumed. Not only this, but they must be offered in language, weights, measures, and values which the merchants and people of the purchasing country can understand. The theory that catalogues and price lists in American weights, measurements, currency, and terms of payment will draw orders, provided the claim of superior quality is made strong enough, has been fatally exploded by experience. The Americans who have won conspicuous success in the German market have been those who have come here, studied the requirements of the trade, and then either set up their own depots and system of distribution, or formed close working relations with German houses of high standing and established connections throughout the Empire.

Either this, or recourse must be had to the traveling salesman with his sample bag and persuasive address. For effective service, he should be fluent in German, with a knowledge of local trade conditions, and an American training and experience in the art of describing, explaining and selling the particular thing that he has to offer. He should be able to tell how large and heavy each article is in metric units, and what it will cost free on board at Hamburg or Bremen. Germany is traversed twice a year by salesmen from French, English, and Belgian exporting firms who can tell all these things, and if Americans are to successfully compete with them, they must be not less competent and enterprising, and must spare no effort to meet these competitors on equal terms.—Frank H. Mason, Consul-General at Berlin.

* See Advance Sheets No. 1372, June 20, 1902; Consular Reports, No. 263 (August, 1902).

A MEDIÆVAL TREATISE ON SURVEYING.

Prof. Hammer, of Stuttgart, who has from time to time published interesting contributions to the history of geodesy and of surveying instruments, has given in a recent number of the Zeitschrift für Vermessungswesen a detailed account of Reinhold's treatise on surveying and mine surveying, a little-known work that enjoyed great popularity in Germany in the Middle Ages. In the bibliography appended to Brough's "Mine Surveying" (ninth edition, 1902, p. 360), Reinhold's book appears as the earliest independent treatise on the subject. In a view of the far-reaching influence exercised by the work, a brief analysis of the contents may not be without interest.

The title of the book is "Gründlicher und warer Bericht vom Feldmessen." It was published at Saalfeld in 1574 by his son, Erasmus Reinhold. Reinhold senior was born at Saalfeld in 1511 and died there of the plague in 1553. From 1536 until his death he was professor at Wittenberg. The main contents of the book would appear, therefore, to have been written in the middle of the sixteenth century. The preface, written by Erasmus Reinhold junior, a physician, gives examples of errors made in surveying. Thus, a large forest was measured thrice; the first determination gave an area of 26,000 acres, the second 36,000 acres, and the last 27,000 acres. The author divides his "Bericht" on surveying into five sections. The first deals with the four rules of arithmetic, the extraction of square roots, etc.; the second deals with the calculation of areas; the third with the dividing up of land; the fourth shows how the rules given may be applied in districts where other measures of area are in use; and, lastly, the fifth section enumerates the rules of surveying so as to enable, as the author puts it, a common man of sufficient intelligence to carry out his own measurements without further great ado. The second part of the work is devoted to an account of the quadrants and of the compass, and to a treatise in nineteen chapters on mine surveying.

In the first part of his book Reinhold complains that it is rare to find a town which uses the same names and sizes for field surveying as its neighbors. Morgen, Juchart, Tagwerk, Mannsmahd, Hufe, Hufacker, Artacker, etc., are among the units of area met with. He therefore carefully enumerates his measures of length and area, with the symbols used for them throughout the book. The unit of length is the rod (Ruthe) of 16 feet (Werkschuh), each of which is again divided into 16 finger-breadths (Fingerbreit). The unit of area is the acre (Acker) of 150 square rods (gevierdt Ruthen). The Werkschuh, on which his whole system of measures is based, is dealt with by Reinhold in a peculiar manner, very characteristic of the period. He says in effect: how long, however, a Werkschuh is, is known to everyone, or can easily be ascertained from any carpenter, mason or cabinet-maker. Later on in the volume he gives a woodcut showing the length of a third of this foot, from which it is evident that the Werkschuh was 281 millimeters long, and consequently the Ruthe was 4.50 meters long, which is in close accord with the old Brunswick rod of 16 feet (4.566 meters). A square rod would represent 20¼ square meters, and the unit of area, the Acker, would contain about 3,040 square meters, which is in fair accord with several of the Morgen in use in Germany before the introduction of the metric system. For the measurement of lengths, Reinhold advocates the use of a cord or rods. A wire cord is preferred to a hemp one, as not being affected by weather or by varying tension. For setting out a right angle the author makes use of the right-angled triangle with the sides 3, 4 and 5. He also recommends the numbers 20, 21 and 29, as well as the approximation with the numbers 12, 12 and 17 ($12^2 + 12^2 = 288$, whereas $17^2 = 289$). In reference to the latter method, he reminds the reader that he writes for the common man who does not require everything to be weighed on a gold-balance. Areas are calculated by means of rectangles, trapezoids and triangles, attention being given to the measurement of lakes and woods and other polygonal figures in which diagonals cannot be measured. For the measurement of angles the compass is used. It is gradu-

ated into single degrees, each 5 degrees being numbered consecutively from 0 to 360 degrees. The direction of the pointer in the illustration given represents a westerly declination of about 6 degrees. Lastly, the trigonometrical solution of triangles by the aid of a table of natural sines is explained. The next section of the work deals exhaustively with the division of land. Errors, it is pointed out, frequently occur which a good surveyor could easily prevent. Every prince and town, therefore, should, as the author quaintly puts it, have a licensed, but nevertheless competent, surveyor. The second division of the whole work is devoted to mine surveying. The instruments described include the compass, a good quadrant, a water-level and a hanging clinometer. The unit of length in mine measurements was the Lachter (fathom) of 6 shoes, and the technical terms then used were much the same as those now in vogue in German mines.

Such in brief are the contents of this remarkable treatise written 350 years ago. Comparing it with some of the most recently published text-books on surveying, it is depressing to find how little is the progress that has been made in the instruction in this important branch of engineering. In a large treatise on the subject published this year the statement is made that a slight knowledge of geometry is necessary, and consequently a chapter is inserted in the middle of the book dealing with geometry, trigonometry and logarithms. The development of the theory of measurements and the mathematical principles on which it is based are neglected, and the author confines himself to enunciating mechanical rules for the testing of surveying instruments and for carrying out surveys. This rule-of-thumb method of education was not enough for Reinhold in 1550, while in 1782 Prof. Lempe, in his lectures at the Freiberg School of Mines and in his text-book, went still further by urging the necessity of learning and applying arithmetic, geometry, plane and spherical trigonometry, and even analytical geometry and the elements of the differential and integral calculus, as the surest basis of a successful study of mine surveying.—Nature.

THE PACIFIC CABLE.

As announced in our last issue, the British Pacific cable was completed on Friday, and the usual congratulatory messages have been conveyed through it. The engineers' certificate has now been given, and it is expected that the arrangements will be complete for opening the cable route for public use in a few weeks' time. We will not here recapitulate the history of the scheme, nor need we give the text of the various congratulatory telegrams; we will deal in this article rather with the technical features of the cable.

Fig. 3 is a sketch map showing the route, which was selected in such a way that the cable only touches British territory. The length of the sections and the date these were laid is as follows:

Section.	Laying.		Length laid.
	Begun.	Finished.	
	1902.	1902.	Nauts.
A. Vancouver–Fanning Island	Sept. 18	Oct. 17	3,458
B. Fanning Island–Fiji	Oct. 19	Oct. 31	2,043·1
C. Fiji–Norfolk Island	April 3	April 10	981·5
D. Norfolk Island–Southport	March 13	March 18	836·7
E. Norfolk Island–Doubtless Bay...	March 20	March 26	518·7

It will be seen that the total length is 7,838 nauts. The average speed of laying was 198 naut per day. The time between the commencement and termination of the Vancouver and Fanning Island section does not represent time taken for actual laying as, owing to the extreme weight of the cable, the entire section could not be carried, and there was a wait for another cable ship with the shore ends. This section from Vancouver to Fanning Island, it will be noticed, is 3,458 nauts in length—the greatest length of cable ever laid in one section. On this account the core had to be given a larger size than that possessed by the other sections. From Vancouver to Fanning Island the copper weighs 600 pounds per naut, and the gutta-percha 340 pounds per naut. Outside the seven-strand of the copper conductor of the Vancouver-Fanning Island core are four flat wires which are given a long lay and flattened down round the central copper strand. In the second section, from Fanning Island to Fiji, the corresponding figures are 220/180, and the remaining three sections are all 130/130.

The armoring of the deep sea portion of this cable consists of 18 galvanized wires of No. 14 (0.038 inch), each wire taped and compounded. Two tapes and compounds form the outer serving.

The breaking strain of this cable is about 8 tons, with between 3 and 4 per cent elongation. Its weight in air is 2.1 tons per naut, and in water 1.15 tons per naut. Sections of the various cable constituting the Vancouver-Fanning Island section are shown in Fig. 1. The rock cable is armored with 10 wires of No. 2 gage, then six wires of No. 00, the latter being wound spirally with a very short lay, the latter fact accounting for the peculiar shape of the section in spite of the wires being circular. This rock cable weighs 21 tons per naut. The heavy shore end weighs 16½ tons per naut and is insulated first with 12 No. 6 gage wires and then with 14 No. 1. The heavy intermediate cable is armored with 10 wires of No. 2 gage and weighs 8 tons per naut, and the light intermediate weighs 5 1-3 tons per naut and is armored with 12 wires of No. 6 gage.

Fig. 2 shows the types of cable used on the Fiji-Norfolk Island-Queensland and New Zealand sections. The core, as already stated, is 130/130 and the armoring is as follows:

Rock cable	10 wires	....	No. 2 gauge.
	6 "	....	No. 00 "
Heavy shore end	12 "	....	No. 8 "
	14 "	....	No. 1 "
Heavy intermediate	10 "	....	No. 2 "
Light intermediate	12 "	....	No. 8 "
Second light intermediate ...	10 "	....	No. 6 "
Deep sea	16 "	....	No. 13 "

The bay cable is twin, and is armored with 18 wires of No. 9 gage. For the shore ends and intermediate cables brass tape is employed as a protection against the teredo.

To show the importance of the preliminary survey before the cable was laid, it may be mentioned that about 100 miles from the starting point of the cable off Australia there was a steep submarine mountain lying in what would have been the direct line of route between Southport and Norfolk Island. Had the cable been laid straight over this a breakage would have been certain in the course of time, for when the soundings were taken the depth decreased almost suddenly from 2,400 fathoms to 220 fathoms. This elevation in the ocean bed was termed Britannia Hill, and a slight *détour* was made to avoid it.—Electrician.

THE AURORA, ELGIN AND CHICAGO RAILWAY.

THE Berlin-Zossen road, now famous in electrical history for the high-speed tests carried out upon it by the two great German electric companies, has for its counterpart in this country the Aurora, Elgin & Chicago Railway, constructed by the General Electric Company. The American road, however, differs from the German line in several ways. Both roads, to be sure, were built primarily for speed. The Berlin-Zossen line, however, is simply an experiment; the Aurora, Elgin and Chicago Railway, on the other hand, is a permanent electric road.

Broadly, the main difference between the two roads is to be found in the nature of the current used. At the power stations of both lines three-phase alternating current is generated. On the German line the high-tension alternating current is fed directly to the motors of the cars or locomotives; on the American road the alternating current is converted into direct current and supplied to a third-rail.

The entire line of the Aurora, Elgin & Chicago Railway, when completed, will have 82 miles of track. For a distance of 20 miles west of Chicago the map shows a belt of towns along the Fox River. The new road touches the Fox River at its three largest towns, Aurora, Batavia and Elgin. Since all the population in the tributary Fox River towns, together with the suburban population mentioned, amounts to a total of 115,289, not including rural population, it can be seen why the builders were content to incur liabilities of $91,219 per mile in order to provide adequate railway connections with Chicago.

The prime requisite of a road built for the purpose of knitting a city and its suburbs more closely together, is speed. To obtain a franchise whereby permission would be allowed to operate at the ordinary schedule of 15 to 20 miles an hour would have been a matter of no great difficulty; but higher speeds are necessary. Since there was a population to justify it, a private right of way was secured for the track and roadbed.

Both the track construction and the electric equipment were designed to permit the very fastest schedules possible—65 miles per hour maximum speed, 40 miles per hour with stops three miles apart on local service.

The enterprise was daring both from an electrical and financial standpoint. In order to accelerate a car from a standstill up to a rate of 50 miles per hour in 25 to 30 seconds, and to maintain a speed of 65 miles per hour, it was possible to use only the multiple-unit system.

For the motor equipment, four 125 horse power G.E.-66 motors were adopted, together with the General Electric Company's type M train-control system, with small master controller on each platform, operating magnetic contact makers or drivers under each motor. Every axle motor of one or two car trains will be driven. In three-car trains one car will have no motors. The Niles car, upon which these motors were placed, measures 47¼ feet over bumpers and 39.4 over body, a length selected in order to permit the cars to round the sharp curves at the Chicago Union loop. The weight of the cars is 74,325 pounds, of which 17,120 pounds is taken by the motors alone. The gear ratio is 1.6121. The seating capacity of each car is 56. The Christensen straight air brakes with independent motor-driven compressors and automatic

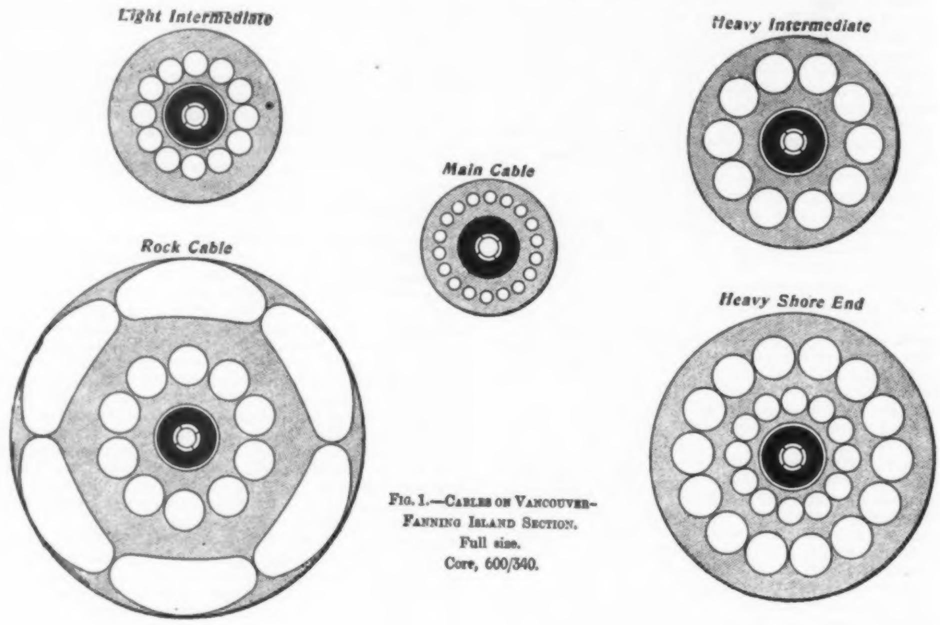


FIG. 1.—CABLES ON VANCOUVER-FANNING ISLAND SECTION. Full size. Core, 600/340.

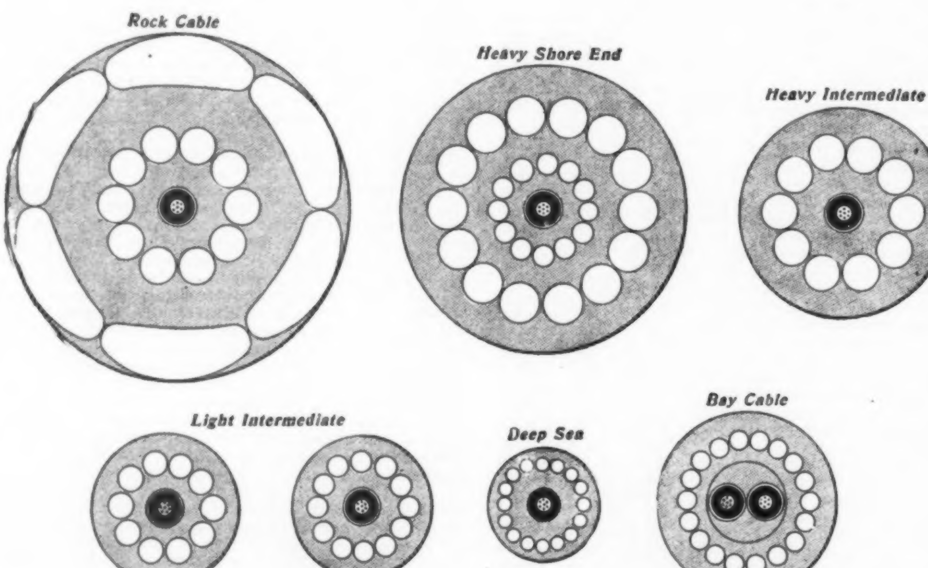


FIG. 2.—CABLES USED ON FIJI-NORFOLK ISLAND-QUEENSLAND AND NEW-ZEALAND SECTIONS. FULL SIZE. CORE 130/130.

motor regulator are employed, the motor regulator being controlled by electric car contacts on the air-pressure gage.

The roadbed for single track is 16 feet wide with 9 inches of gravel ballast. The roadbed for double track is 28 feet wide. Double tracks are laid 16 feet between centers.

Current is supplied from a third-rail, made with a lower percentage of carbon than the rails in order to give it better conductivity.

The tracks are standard T, 80 pounds to the yard, in 60-foot lengths, joined to four-bolt angle-bars 28 inches long. There are 2,840 regular ties to the mile; each tie measures 6 inches x 8 inches x 8 feet. Every fifth tie is 9 feet long, and carries on one end an insulating support for the third-rail. With the exception of two 16-degree curves at Waldheim Cemetery, there is nothing to require a reduction of speed from 70 miles per hour.

A special design of third-rail insulator is used. Instead of omitting the third-rail at the beginning of a cross-over, to prevent catching of the contact-shoes on cars which are passing along the main line, the third-rail is bent down so as to clear the shoe, thereby obviating some necessary underground connections were a separate insulated section of third-rail put in for the cross-over. At highway grade crossings, however, it is of course necessary to omit a short section of the third-rail.

In order to protect the ends of the conductor and lead-covered sheath which is used for connecting the track of the third-rail at highway crossings, a special terminal has been designed by Mr. Gonzenbach, serving the dual purpose of a connector and a protector of the insulator at the end of the cable.

The power of the entire road is supplied by a high-tension alternating current from a power-house at Batavia on the Fox River. The transmission is by 26,000-volt, three-phase current to six sub-stations.

The high-tension lines are supported on cross-arms 24 inches apart. Telephone lines are carried on cross-arms 7 feet below the lower transmission cross-arm. Two telephone circuits are used, one for general business and the other for dispatching.

Since the third-rail has sufficient carrying capacity to conduct the current from the sub-station to the trains, it is not necessary to use direct-current overhead feeders. It therefore follows that the overhead line carries only the 26,000-volt, three-phase, high-tension feeders, by which the various sub-stations and the telephone circuits are supplied.

A departure has been made from the usual practice in leading the transmission under instead of over a number of pole lines. Instead of carrying the high-tension lines over every other pole line, they lead under all unusually high telephone lines, with guard-wires strung between rectangular frames surrounding the cross-arms.

Since the fluctuations in load are apt to be violent, the arrangement of the direct current and sectioning of the line is a matter of importance.

The third-rail between any two sub-stations is fed from the sub-station at each end so that it forms in reality a continuous section. The actual sectioning takes place only at the sub-stations. Each sub-station, therefore, feeds both ways, so that all the third-rail sections on the entire line are connected by the sub-station bus-bars and feeder panels. It follows that the load can be divided among the sub-stations so far as the conductivity of the third-rail will permit. The excessive load of one section will not be imposed upon the nearest sub-station. Automatic circuit breakers at the two sub-stations will open in case of short-circuiting on any part of a third-rail. The third-rails of the tracks are not connected permanently, but constitute separate sections, connected through the medium of sub-station feeder panels and bus-bars, as in the previous cases.

Not the least interesting feature of this road is the plan of switching, on the high-voltage side of step-up and step-down transformers—probably the first attempt of this kind in high-tension alternating-current distribution plants. Each generator and its transformers constitute practically a 26,000-volt machine. That it is possible to do away with all low-tension storage batteries by using the 26,000-volt circuit alone, is due chiefly to the improvements that have been made in oil switches which will open circuits of over 20,000 volts.

The main generator current, after passing through its three step-up transformers and being raised to 26,000 volts, passes through current transformers. After passing the current transformers, the leads are taken to the oil-switch, from which they pass to the alternating-current 26,000-volt bus-bars. From the generator panels, the 26,000-volt bus-bars pass to the high-tension feeder-panels, each feeder thus passing through an oil-switch, and then through a current transformer which operates a feeder power-factor meter, and an ammeter. Thereupon the current flows through an overload relay which closes a switch tripping circuit whenever the current exceeds the amount for which the relay is set.

It is possible to operate the main factor switches by hand as well as automatically by overload.

Three 1,500-kilowatt three-phase electric generators have been installed. The sub-station equipment comprises two 500-kilowatt rotary converters with a bank of transformers for each. In order to keep the transformers cool, the sub-stations have air-tight basements, in which air is kept under pressure by a blower.

Each rotary converter has its bank of transformers controlled by an oil-switch machine. Each converter's alternating current panel, while having no high-voltage wires, may nevertheless be regarded as a high-tension panel, since its instruments and controlling switches all relate to the 26,000-volt line before it passes to the step-down transformers. After passing the main switch, which is operated by a hand switch or by an overload relay on the converter-panel, the high-tension line passes through current transformers for the switchboard instruments and then to the three main step-down transformers.

The rotary converters can be started either by direct current from the third-rail or by alternating current, and are connected six-phase.

The road has not been in operation long enough to permit the trains to run at the speed planned. It is first necessary to permit the new roadbed to settle, and the trainmen to accustom themselves to the service. When the track ballast is settled it is believed, from the results so far obtained, that local trains can be run to Chicago and Aurora in one hour. A through service is contemplated, with a running time of 45 minutes with a few stops, the distance being 34.6 miles.

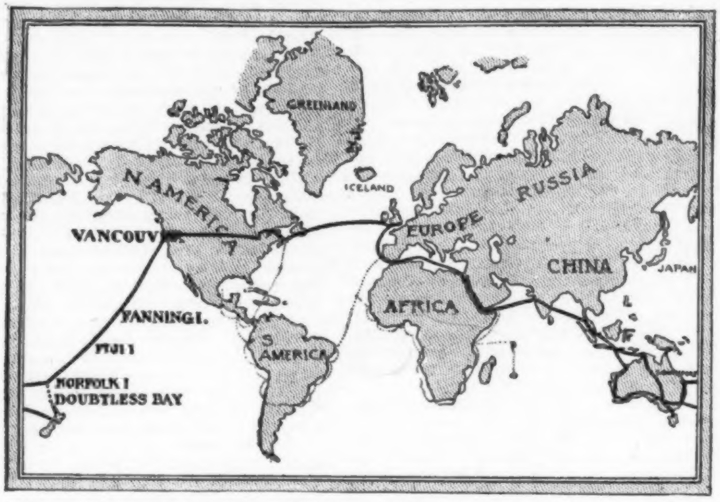


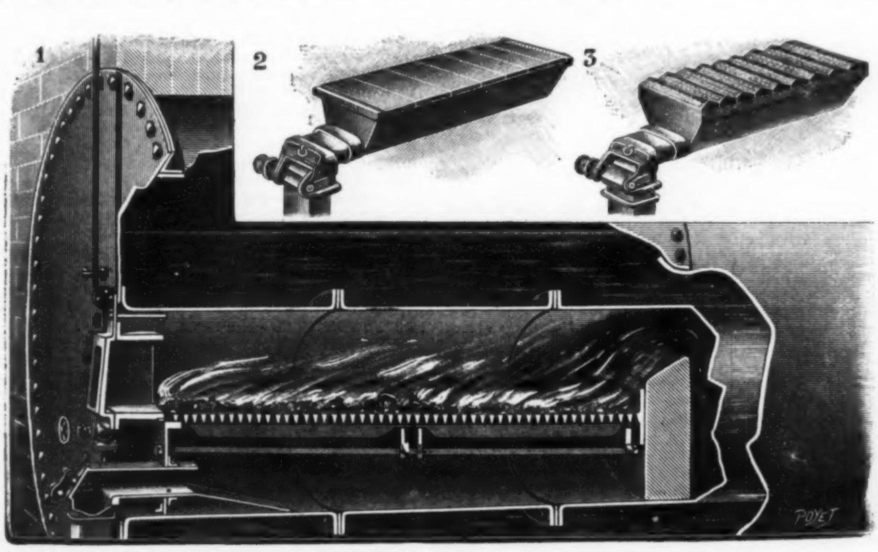
FIG. 3.—MAP SHOWING THE LINE OF THE ALL-BRITISH CABLE.

GRATES FOR FINE FUEL.

THE furnace illustrated herewith, devised by Herr Kudlicz of Prague and improved by M. Donders of Nancy, is designed for the burning of fine fuel (coal dust, sawdust, etc.), which, as is well known, is apt either to fall between the grate bars or through its pulverulence to obstruct the passage of the air that is necessary to assure combustion.

The grate is formed of a series of juxtaposed cast iron plates from 3 to 4 centimeters in thickness and provided with conical apertures which are 20 millimeters in diameter at the entrance and but from 3 to 4 millimeters at the exit. There are something like 1,300 of these apertures to the square meter of grate. In fact, then, the section of the passageway of the air that is to permit of the combustion of the fuel is quite small, since it does not exceed from 1 to 1.5 decimeter per square meter of grate. The furnace, however, is designed for operation through a steam or forced draught blowing apparatus. The perforated plates that perform the part of a grate constitute the upper face of a flat iron plate and cast iron box which extends the entire width of the furnace properly so-called and is slightly inclined toward the rear. For the convenience of construction, the box may be composed of several partial boxes all connected in front with a blast-pipe box that projects from the front of the boiler and contains steam injectors for drawing in the external air. In this way, there enters through the grate apertures a mixture of air and steam which slightly raises the fine fuel arranged upon the plates and assures its combustion under excellent conditions. It is unnecessary to say that the steam of the injectors is furnished by the boiler itself, after it has once got under pressure. The current of finely divided air that constantly passes through the apertures of the grate assures the cooling of it and prevents the adhesion of clinkers, which may be easily removed. As a small quantity of ashes may find their way to the bottom of the box through the orifices in the plates, the draught-pipe box is provided with a hinged cover that permits of the introduction of a small scraper for the removal of the accumulation.

It may readily be seen that this mode of combustion through the insufflation of air permits of dispensing with tall chimneys. The combustion, however, is complete and gives but little smoke, while the increase in the production of steam easily compensates for the quantity used in the injection of the air, at least when the dust of good coal is burned. For the above particulars and the engraving, we are indebted to La Nature.



THE KUDLICZ GRATE.

1. General view of a furnace. 2 and 3. Details of grate bars.

WONDERFUL OLD MEN.

MEN of thought have always been distinguished for their age. Solon, Sophocles, Pindar, Anacreon, and Xenophon were octogenarians. Kant, Buffon, Goethe, Fontenelle, and Newton were over 80. Michelangelo and Titian were 89 and 99 respectively. Harvey, the discoverer of the circulation of the blood, lived to be 80. Many men have done excellent work after they have passed 80 years. Landor wrote his "Imaginary Conversations" when 85. Izaak Walton wielded a ready pen at 90. Hahnemann married at 80 and was working at 91. Michelangelo was still painting his giant canvases at 89, and Titian at 90 worked with the vigor of his early years. Fontenelle was as light-hearted at 98 as at 40, and Newton at 83 worked as hard as he did in middle life. Cornaro was in far better health at 95 than at 30, and as happy as a boy. At Hanover Dr. Du Boisy was still practising as a physician in 1897, going his daily rounds at the age of 103. William Reynold Salmon, M. R. C. S., of Conbridge, Glamorganshire, died on March 11, 1897, at the age of 106. At the time of his death he was the oldest known individual of indisputably authenticated age, the oldest physician, the oldest member of the Royal College of Surgeons, England, and the oldest Free Mason in the world.

JAPANESE POLICE AND THE RATS.

WHEN Japanese officials undertake a measure *pro bono publico*, they carry it out with a thoroughness unknown in the "Western World," as witness the following which we translate from the Drogisten Zeitung:

Last month the police of Kobe distributed to every house in town a package of arsenic, with directions for the use of the poison printed on each package, which latter was to be used in the destruction of rats, in accordance with the plan of the Department of Health, in fighting the plague. A very prominent citizen of Kobe, and a political leader of some note, on the day after the distribution was made, called at the office of the Kobe Chronicle and lodged a complaint to the effect that he had been grossly insulted by the police.

According to his account, a police officer on the foregoing day had walked into his dwelling and, without a word, handed him a package marked "Arsenic." "What is that?" asked he. "That's for you," answered the officer. "For me?" inquired the astonished citizen, in whose mind, no doubt, visions of a hint to

betake himself to the unknown shore, after the "good old" Japanese fashion, were floating. "Yes—for—you," repeated the policeman, pausing after each word, to emphasize it. "The order has gone forth that all vermin shall die!" This was all that the astonished editor could get out of the wrathy politician and the latter went away still raging against "the insult the police had put upon him."

Wonderful indeed is the notice that was printed on these same packages. "Eat not of the contents," it reads, "for it is forbidden. If anybody, by carelessness, eats of it, let him report at once to the nearest policeman, and if none is to be found then report to the coroner! When a rat is killed, report it to the police and they will send a commissary to take care of it. Do not touch it yourself, as this is forbidden. If any arsenic is left over by the rats, notify the police, who will remove it. *Give notice to the rats that they must not die in their holes, as the latter is forbidden under the heaviest penalties.*"—National Druggist.

[Continued from SUPPLEMENT No. 1405, page 22515.]

THE CONVERSION OF AMORPHOUS CARBON TO GRAPHITE.*

By FRANCIS J. FITZGERALD.

CERTAIN natural graphites have a peculiar property of swelling up when treated with nitric acid and then heated to a temperature of about 200 degs. Moissan investigated this phenomenon and found that he could produce these swelling graphites in the electric furnace. He also made some experiments which seem to show that the swelling is caused by a rapid evolution of gas contained in the graphite.

Moissan's conclusions are as follows:

"According to M. Berthelot's definition we shall give the name graphite to the usually crystalline variety of carbon of which the density is about 2.2 and which yields a clearly characteristic graphitic oxide on treatment with the oxidizing mixture of potassium chlorate and nitric acid.

"Graphites are found on the surface of the earth and in certain meteorites. They may be divided, as M. Luzi recommends, into swelling and non-swelling graphites.

"The graphites obtained in the electric furnace by simple elevation of temperature are not swelling graphites.

"On the other hand, all those which are obtained in a liquid metal at a high temperature, either by difference in solubility or by simple chemical reaction, have the property of swelling readily. This swelling graphite is very easily prepared in the electrical furnace by boiling platinum in a carbon crucible.

"The swelling of this variety of graphite should be attributed to a rapid evolution of gas.

"Artificial graphites may be amorphous or crystalline. Their density varies between 2 and 2.25. Their temperature of combustion in oxygen is about 660 degs.

"When they are pure they contain no hydrogen.

"A graphite obtained in the electric furnace, not treated with a reagent, but previously heated in a vacuum, does not yield any water when burned in oxygen. On the other hand, ordinary cast-iron, treated with dilute acids, yields hydrogenous and oxygenous compounds which are indestructible at a red heat.

"When a graphite is prepared in the electric furnace its resistance to oxidation is proportional to the elevation of the temperature to which it has been brought.

"A graphite that is easily attacked, like Ceylon graphite, may be made more difficult of attack by heating strongly. This fact establishes the existence of many varieties of graphite analogous to the different varieties of amorphous carbons."†

In 1893 Girard and Street, in a lecture before the Société Internationale des Electriciens, describe a furnace which may be used for the conversion of carbon into graphite. The method consists in causing an arc or series of arcs to play over the surface of the carbon that is to be converted into graphite. It is stated that 85 per cent of the carbon is transformed into graphite by this process.‡

In 1891 Mr. E. G. Acheson, while attempting to obtain a hard crystalline form of carbon, discovered the new compound silicon carbide, now well known as an abrasive under the name carborundum. Recognizing at once the valuable properties of this new compound, Acheson rapidly developed its manufacture and designed a new form of furnace for this purpose. The furnace was a brick box with an open top, and carried carbon terminals at either end. In operating the furnace it was filled with a mixture of sand and coke, and the terminals electrically connected by means of a granular carbon core through which the current passed, heating it to such a high temperature that the carbon in the surrounding mixture reduced the silica and formed silicon carbide. After operating these furnaces, Acheson usually found a layer of brilliant graphite lying between the core and the crystalline carborundum, and examination showed that this was formed by the decomposition of the silicon carbide. The temperature of the core, other things being equal, is a function of its sectional area, and hence if this happens to be somewhat smaller than usual the temperature will be proportionately higher and the silicon carbide in immediate contact with the core will be decomposed, the silicon being vaporized and the carbon left behind as graphite. The granular carbon, usually coke, composing the core of the furnace, also showed change, for the grains became softer, would mark paper like a pencil, left a brilliant polished surface on rubbing, were good conductors of heat and electricity, and were almost chemically pure, containing only about 0.2 per cent of ash. Sometimes petroleum coke was used to form a core, but that material did not yield a carbon, having all the clear characteristics of graphite. The granular carbon that had already been used as a core in a carborundum furnace was known as "old core" and was of much value, owing to its low electrical resistance, for if it was used to form the core of the next furnace the latter could be brought to its working temperature in a very short time. Acheson found that no matter how often this granular carbon was used as a core no further appreciable change in its properties occurred after the first time. Careful examination of the grains of the old core showed Acheson that these were by no means homogeneous, some being dull black in color and nearly as hard as the original coke grains, while others had a brilliant metallic luster and could be cut with a knife like a piece of cheese. Further observation showed that the relative quantities of the dull, hard grains and the brilliant soft variety depended upon the coke used in making the core, and that the results obtained with different cokes depended upon the ash content. Combining these observations with those on the decomposition of silicon carbide, Acheson concluded that a general method for the production of graphite might be found in the formation and decomposition of carbides. The experiments undertaken to test this theory resulted in a patent on the "Manufacture of Graphite," in which Mr. Acheson says:

"I have also discovered, that in order to produce pure graphite from carbonaceous materials there is an indirect conversion, and that the act of formation of the graphite is more in the nature of an act of dissociation of the carbon from its combination with other materials than a conversion of the ordinary carbon into graphite, and that as a preliminary step the carbon has to be combined chemically with some other material. Thus I have found that if the carbonaceous material or carbon used in the process contains a considerable proportion of mineral matter, or if it is mixed with a certain proportion of oxide or oxides such as silica, clay, alumina, magnesia, lime or oxide of iron, the yield of graphite is enormously increased and the product is more satisfactory." *

An experiment which demonstrated the effect of carbide formation very clearly was the following: Two carbon rods, one composed of very pure lampblack carbon and containing less than 0.2 per cent of ash, the other made of petroleum coke carbon which had been intimately mixed with a certain amount of ferric oxide, were heated side by side in an electric furnace. At the end of the experiment the rod that had contained the iron was found to be graphitic; could be easily cut with a knife, took a beautiful metallic luster on rubbing and would mark paper like an ordinary pencil. The pure carbon rod showed little change, was dull black in color, nearly as hard as before heating, and would not leave a mark on paper. One end of this carbon rod, however, was clearly graphite from the fact that it had been exposed to the action of vapors of carbide-forming elements. These vapors had even penetrated to a certain depth in the carbon rod, and in so far as this had occurred the rod showed a brilliant graphite appearance, was soft, etc. This experiment will be referred to again in discussing M. Berthelot's researches.

It might be supposed that the production of graphite in the manner described above would necessitate the mixture of carbon and carbide-forming material in proportions such that the carbon present would be completely satisfied. Acheson's experiments showed, however, that the desired result could be obtained by a very much smaller percentage of the carbide-forming element, which apparently has the power of acting on successive quantities of carbon.

Having finished his preliminary experiments, Mr. Acheson formed a company for working his process of making graphite, and began to produce it on a commercial scale. The furnaces used in the Acheson process for making graphite electrodes and graphite commercially are very similar in outward appearance and magnitude to those used in Acheson's process for making carborundum. They are built of brick, in the form of a long, narrow trough, lined with some suitable refractory material. In making graphite electrodes the latter are manufactured of petroleum coke and pitch, like an ordinary carbon, such as is used in arc lights; but a certain amount of some carbide-forming material, such as silica or iron oxide, is introduced. The electrodes are baked in the usual way and are then ready for graphitization. To perform this work they are placed in a furnace and heated to a temperature above that of the volatilization of such bodies as iron, aluminium and silicon. That the temperature used in the Acheson furnaces is well above this point may easily be demonstrated, as the bodies above named are condensed in the form of their oxides outside the furnace.

In manufacturing graphite for other purposes, such as crucibles, paint, stove polish, etc., anthracite coal is usually employed. Having found a process for making graphite, Acheson next set to work to find a natural carbonaceous substance which would yield a graphite suitable for commercial purposes. He experimented with a great many materials, and finally discovered that anthracite coal gave the most satisfactory results. The furnace is filled with anthracite coal, through the center of which runs a core composed of carbon rods which connect the terminals of the furnace electrically. When cold, anthracite coal is a very poor conductor of electricity, hence the necessity for the core, which acts as a conductor and heats the surrounding anthracite when the furnace is started. Finally, the whole mass is raised to a very high temperature and converted into graphite.

Careful study of the products of the Acheson process has shown that, according to Berthelot's definition, the conversion of the amorphous carbon into graphite is complete, for the oxidizing mixture of nitric acid and potassium chlorate does not produce the least trace of the brown soluble body, characteristic of amorphous carbon, but yields only graphitic oxide.†

The density is increased considerably by the conversion of amorphous carbon into graphite:

Mean value of densities of six electrodes before graphitizing	1.90
Mean value of densities of the same after graphitizing	2.19

The electrical conductivity of the carbon is greatly increased by conversion into graphite, as is shown by the following results obtained by Mr. P. M. Lincoln, Resident Electrical Engineer of the Niagara Falls Power Company:

Resistance of 1 cubic inch of amorphous carbon electrode	0.00124 ohm.
Resistance of 1 cubic inch of graphite electrode	0.000320 ohm.

The purity of the graphitized carbon is greater than that of the amorphous from which it is made, for a greater or less quantity of the contained impurities is volatilized, the final purity depending on the temperature to which the carbon has been raised and the time expended in heating. A specimen of anthracite coal was analyzed and found to contain 5.783 per cent of ash. After prolonged heating and conversion into graphite the latter was found to contain only 0.033 per cent of ash. Dr. Foerster, of the Dresden Technische Hochschule, has shown the remarkable resistance of Acheson graphite to disintegration in certain electrolytes.*

In some early experiments on the reduction of oxides by carbons, Dr. W. Borchers used an electric furnace which had for terminals two relatively large carbons connected to each other by a carbon rod of much smaller diameter. The small rod was highly heated by the passage of the current and was surrounded with the mixture of oxide and carbon on which he wished to make experiments. Like Despretz, Borchers found that when, in manipulating the terminal carbons, he applied pressure to the ends of the small highly heated rod it bent, and that on cooling it assumed a hard crystalline state. He found that the greater the impurities the lower the temperature at which the rods bent and the harder they were on cooling; also that substances which form alloys or decomposable compounds with carbon further its crystallization. Finally he describes an apparatus with which he believes valuable results might be obtained along the lines of his experiments.†

We may notice briefly a patent granted to Mr. H. Y. Castner in 1896 for an "Anode for Electrolytic Processes," in which is described a process for heating carbon electrodes by means of electricity to a very high temperature, with the result that a "graphite-like form of carbon is produced." It might be supposed that Castner's electrode was an anticipation of the Acheson graphite electrode were it not that Castner states that after treatment the electrode "will be found to be of decreased density." The Acheson graphite electrode, being actually converted into graphite, has a considerably higher density than the amorphous carbon of which it is made. In describing his process Castner also states that the temperature produced is such that "the carbon will give off the more inflammable material it contains." We may conclude, therefore, that Castner's process was nothing more than the electrical baking of carbon anodes.‡

September 2, 1901, a German patent granted to John Rudolphs and Johannes Härden, of Stockholm, was published. The specification for this patent describes a "process of obtaining graphite from carbon by means of electrical current." Attention is called to the fact that heretofore carbon has been converted into graphite by heating alone, care being taken to avoid oxidation during the process. The inventors propose to graphitize carbon by the simultaneous action of a high tension alternating current of high frequency, and a heating current of the usual kind. It is claimed that "the conversion of the carbon to graphite proceeds far more rapidly than by electrical heating alone; furthermore, experiments have shown that by means of this invention it is possible to graphitize much larger carbon pieces than is possible by known methods. This advantage may rest upon the fact that the high-tension alternating currents of high frequency produce very rapid ether-vibrations, which seem capable of favorably influencing the molecular alterations of the carbon pieces under treatment. . .

"With the object of preventing the combustion of the carbon pieces to be treated, it is advisable to conduct the operation in an exhausted chamber or in the presence of inert gases in order to prevent, according to known methods, access of air to the glowing carbon."

Finally the following claim is made in the patent:

"Process of obtaining graphite from carbon by means of electric currents, characterized by the fact that a low-tension heating current either in the form of a direct current or of an alternating current of low frequency (about 25 to 100 alternations per second), and a high-tension alternating current of high frequency (at least 50,000 alternations per second), are permitted to act simultaneously upon the carbon."§

This review of the more important work done on the production of graphite makes it clear that the various experimenters are by no means in agreement as regards the results they have obtained. Despretz in his experiments was endeavoring to show that carbon could be fused, welded and volatilized and thought he had done so. Moissan, however, in his experiments never found any sign of fusion, and concludes that vaporization occurs without previous fusion. In some of his experiments, at least, Despretz probably mistook the formation of fusible carbides for fusion of carbon. If a carbon rod is thoroughly impregnated with iron oxide and then heated electrically to a temperature somewhat below that of the volatilization of iron it will be found to be covered with little fused globules having a brilliant black metallic luster and leaving a mark on paper like graphite. Examination of these globules proves that they are composed of iron intimately mixed with graphite, which has been formed by the method of "different solubilities" and not by fusion of the carbon as Despretz supposed. It is difficult to offer any explanation of Despretz's experiment with the anthracite which "spread out on the crucible like a piece of black glass." In the commercial manufacture of graphite, hundreds of tons of anthracite have been completely converted into graphite, but no phenomenon like this has ever been observed. The ash in anthracite coal is usually very evenly distributed, as may be seen by burning a lump

* Journal of the Franklin Institute.

† Le Four Electrique p. 110, 111.

‡ Becker: Manuel d'Electro-Chimie, p. 449-458.

* U. S. Patent, 568,323, September 29, 1896.

† Journal of the Society of Chemical Industry, May, 1901.

* Zeitschrift für angewandte Chemie, June 25, 1901.

† Zeitschrift für Elektrochemie, March 20, 1897.

‡ U. S. Patent 572 472, December, 1896.

§ German Patent No. 123,692, Class 121, February 28, 1900.

of the coal; but it is not uncommon to find a very large excess of ash in part of a specimen that otherwise contains a low percentage. It is possible that the anthracite used by Despretz contained very little ash as a whole, but that the particular piece taken in this experiment was very impure. Equally remarkable is the experiment where the carbon rods were impregnated with silica which was volatilized without producing any change in the carbon. As Despretz was looking for the fusion of carbon he may have overlooked other changes in its properties. Despretz's conclusion that any carbon becomes proportionately softer as it is heated for a long time to a high temperature is incorrect. Take, for example, the ordinary manufactured carbon, the hardness of which is increased by prolonged baking at a very high temperature, or take some forms of anthracite coal, which may be so greatly hardened by heating for some time to a high temperature out of contact with air that they will readily scratch glass.

Berthelot's researches bring out very clearly the peculiar properties of the different forms of carbon and the relations existing between the different states of the same element, thus lessening to a great extent the apparent incongruity of the results obtained in the work of different experimenters. Some of these incongruities are due to the ambiguity in the use of the word graphite. Berthelot's definition of graphite as that form of carbon which on oxidation at low temperatures yields graphitic oxide is perfectly satisfactory from the chemical point of view, but it is not always satisfactory in practice; for example, as Berthelot himself points out, some forms of carbon which will come under his definition will not mark paper. Reference has already been made to one of Acheson's experiments in which two carbon rods, one containing metallic oxide and the other being pure, were heated side by side in an electric furnace. Subsequent examination showed that both carbons could be converted into graphitic oxide, and hence that they both were graphites according to Berthelot's definition. Nevertheless, the carbon which had originally contained practically no metallic impurities had none of those properties which are ordinarily recognized as characteristic of graphite. Incidentally, it is worth noting that an experiment on the relative incombustibility of the carbons showed that the carbon which had originally been pure oxidized nearly 100 per cent more rapidly than the other carbon. The conclusion to be drawn from a comparison of Berthelot's and Acheson's researches seems to be that while all true graphites yield graphitic oxide, all bodies yielding that compound are not necessarily graphites suitable for practical purposes. In view of the fact that various kinds of hard and soft graphites produced by artificial means are now being put on the market, and that varieties of amorphous carbon (notably retort carbon) are also sold under the name of graphite, it would seem to be advisable to revise the nomenclature of carbons, reducing it to a more rational and practical form that will be free from all such ambiguities.

The experiments on the separation of carbon from the carbides of boron, iron and manganese are particularly interesting, showing, as they do, that in order to produce graphite the method of decomposing the carbides is by no means indifferent. The boron carbide alone yielded graphite by Berthelot's method of separation, while Acheson's method of decomposing the same carbides produced graphite in every case.

So far as Berthelot's experiments went amorphous carbon is not converted into graphite by simple elevation of temperature. In order to bring about this transformation the presence of oxygen, or some other body, seems to be necessary, or an electrical influence must be present. In the case of arc-light carbons special stress is laid on the fact that graphite is produced to an appreciable amount on the negative pole only, and the examination of Despretz's capsules showed that they were converted into graphite "at the negative pole."

The most interesting of Moissan's methods of transforming amorphous carbon into graphite, as compared with the commercial method, is the conversion by "simple elevation of temperature." While his investigations show clearly that heat has a most distinct effect in bringing about the polymerization of both carbon and graphite, yet, in view of Acheson's work on the remarkable part played by various carbide-forming substances in effecting the transformation of amorphous carbon into graphite, none of Moissan's experiments is rigidly conclusive in demonstrating that the change is effected solely by elevation of temperature. Even placing the specimen of carbon in a covered carbon crucible does not necessarily protect it from the action of the metallic vapors which must invariably have been present in Moissan's furnace, since at high temperatures the densest carbons are very porous. Moissan refers to this porosity in the description of his tubular electric furnace,* and in certain experiments made at the works of the Acheson Graphite Company, very dense carbons at high temperatures were found to be astonishingly porous to metallic vapors.

The experiment cited as proving the vaporization of carbon outside the arc is difficult to understand when taken in connection with Acheson's production of graphite by the decomposition of silicon carbide. In Moissan's experiment, silicon was boiled and its vapor combined with "the carbon which descends from the upper part of the tube," and formed silicon carbide. Acheson placed a mass of silicon carbide in an electric furnace and heated it to a high temperature, so high that the carbide was decomposed, the silicon being completely vaporized, while the carbon formed a graphite skeleton of the crystals, the angles of which were perfectly clear and sharp, showing that there had not been the smallest vaporization of the carbon. In the description of Moissan's experiment we are not told whether an inert gas was passed through the tube or that any special precautions were taken to avoid all possibility of the entrance of air during the heating. If this were not done, carbon monoxide gas would be formed, and in contact with a relatively large mass of silicon vapor would probably be reduced with the formation of silicon carbide crystals and silica in the form of vapor. The silica vapor in contact with a large excess of carbon (the walls of the tube and the carbon boat) would in turn be reduced, silicon carbide and carbon monoxide being formed. This explanation is possible, in view of the fact that at very high temperatures the direction of the reducing action seems to depend largely on the relative masses of the reacting bodies. As for the light black lining of the tube "produced by the condensation of the carbon vapor," that could be produced by the disintegrating action of the oxygen of the air playing upon the walls of the tube. Some such action seems more probable than the supposition of vaporization, since the latter would require the condition that there should be no drop in temperature between the outside of the tube, on which the arc is playing, and the inside.

Here attention must be called to an interesting article by Clinton Paul Townsend, in which he discusses the work of the various experimenters, and finally suggests that their results may be reconciled by the hypothesis that "the preliminary ionization of the carbon is essential to the production of graphite. For it will be noted that when Moissan speaks of 'elevation of temperature' he means the heat of the electric arc, whereas Acheson and Borchers refer to the heat developed in a carbon resistance. In the former case conditions favorable to the ionization of the carbon are present, while in the latter such effects are excluded. . . .

"Other of the observations before referred to tend to confirm the view that the production of graphite is due to more than the simple heat-effect of the current. Berthelot's supposition that the mixture of the two forms of carbon, which results from the passage of an electric discharge through hydrocarbons and cyanogen, is due to the joint action of heat and electricity, appears eminently probable. . . . If we re-examine the work of Despretz we find that whenever the arc was used the transformation to graphite was readily accomplished, even though the ash-content of the carbon were only one part in 7,000; but when the carbon, as a filament, was directly included in the circuit, the results are less positive, and the production of graphite seems to follow either the presence of a large admixture of ash, or the rupture of the filament." *

The process described by Rudolphs and Härden in their patent is interesting, but we have not been able to find any more details of the method than those given in the patent.

The results obtained by Borchers in his experiments tend to show that carbide-forming substances "further the crystallization of carbon," and so far confirm Acheson's observations on the important part played by these bodies in passing from one allotropic form of carbon to another; but they do not form good ground for the claim of priority advanced by Borchers,† for they were published long after Acheson's results were made known in his patents.

It may be well to note here an extraordinary claim put forward by Dr. Otto Mühlhaeuser‡ that he is the original discoverer of the fact that graphite is produced by the decomposition of silicon carbide. Mühlhaeuser was employed for a few months as chemist of the Carborundum Company, but the records show that Mr. Acheson's application for the carborundum patent was made before Mühlhaeuser even arrived in America, and the specifications show that Mr. Acheson was then familiar with the production of graphite in this way.§

BECQUEREL RAYS AND RADIO-ACTIVITY.

This most instructive and able evening discourse at the British Association by Prof. J. J. Thomson, F. R. S., of Cambridge, would have received the full share of the popularity it deserved if Prof. Thomson had not lost some time over experiments in which the uninitiated after all saw nothing but a traveling spot of light. There is a good deal of mystery about the subject. Five years ago, as Lord Rayleigh afterward pointed out, in proposing the vote of thanks,‖ we knew nothing of radio-active substances. During Röntgen ray experiments Becquerel noticed that a piece of uranium sulphate, although wrapped up in black paper and copper foil, after having been kept in the dark for days, had left its mark on a photographic plate. Everybody knows the peculiar greenish-yellow fluorescence or phosphorescence of uranium glass and uranium salts. As it might owe that radiation to outside causes, and not be originally self-radiatory, Becquerel prepared some uranium salt entirely in the dark, never exposing it to light at all. The salt proved as active as any other. Those radiations discharge a charged electroscope rapidly, produce the formation of nuclei for fog condensation in C. T. R. Wilson's experiment, and can be deflected by the electromagnet, as Prof. Thomson showed. During the study of these effects, Mr. and Mrs. Curie discovered that radio-activity is not limited to uranium salts, but seems to belong to a good many of the other rare constituents of pitchblende, which is largely an oxide of uranium oxide. Thorium, the chief material of our incandescent mantles for gas burners, is very radio-active. But the Curies¶ discovered three new most active substances—radium, polonium, and actinium. Of these three, radium, which resembles barium, alone could be said to have been properly isolated. We may mention, however, that W. M. Marckwald has succeeded in preparing polonium, or radiobismuth, as it was called at first, on account of its remarkable resemblance to bismuth, in a very characteristic manner. He precipitated electrolytically a blackish film on a bismuth rod held in a solution of bismuth chloride; no bismuth should be deposited under these circumstances. The raw material was pitchblende—which, it is not useless to point out, has also given us helium; and 1 ton of this rare mineral would not contain more than a gramme of polonium. Marckwald obtained 5 milligrammes in all. The polonium behaves chemically exactly like bismuth; and though amazingly radio-powerful, its radiations are easily stopped.

The power of these substances is truly wonderful. Curie had to concentrate his radium 5,000 times before he could discover any trace of its existence in the spectroscope, which we regard as so strangely sensitive; that chemical analysis has so far failed to detect these substances, is therefore not to be wondered at. What the emanations consist of, we do not know. One square centimeter of radium, Prof. Thomson said, could go on radiating for a million years before it loses more than 0.001 of a milligramme of its weight. The energy thrown off in that million of years would yet suffice to melt a layer of ice a quarter of a mile in thickness. Where does the energy come from? Prof. Thomson did not enter into his own speculations on this question, but pointed to the observation made by Elster and Geitel, that negatively charged wires are radio-active. The earth itself is, as a rule, negatively charged. Possibly the constitution of radium enables it to transform the heat energy of its surroundings into electric energy. The problem becomes still more puzzling when we hear of infection with radio-activity. Elster and Geitel's and Curie's whole laboratories were infected with radium. Freshly precipitated radium compounds are very active, but lose their activity; in contact with calcspar, barium sulphate, etc., they impart their activity to the latter, becoming themselves less active, but they recover their activity when isolated. That process may be repeated many times. Prof. Thomson used the following homely simile to explain the relation between radium and barium: Supposing all new-born children were radio-active for the first year of their lives, the radio-activity would then remain fairly constant; and if all the babies of a district were removed to a huge *crèche*, that district would for a time appear radio-inactive, while the *crèche* would radiate powerfully, but only for a time. One cannot help feeling tempted to liken radio-activity to a life process; but Prof. Thomson refrained from speculations, and Lord Rayleigh and Prof. Schuster, who thanked him on behalf of the meeting, did not indulge in them either.—Engineering.

BECQUEREL RAYS AND RADIO-ACTIVE SUBSTANCES—NEW RESEARCHES.

In the Zeits. f. Elektrochem, F. Giesel gives a summary of the work in radio-active substances up to date, showing that at the present time, radio-active substances may be classed in three groups, viz.: (1) Those which are intensely and permanently active, such as radium, actinium, and an unknown substance found by the author to be associated with lead in the radium mother-liquors. (2) Those which are only slightly but yet permanently active, such as uranium and thorium; although it is possible that their apparent activity may be due to the presence of traces of substances belonging to the first group. (3) Those which are either strongly or slightly active, but which gradually lose their activity; such as polonium and certain rare earths from uranium minerals. These are probably converted into the active condition by "induction" by the influence of substances in groups 1 and 2.

A NEWLY DISCOVERED PROPERTY OF ALUMINIUM.

A German investigator has recently discovered an exceedingly valuable and important property of aluminium, which consists in its application as a whetting agent, the effect produced on cutlery set with it being most astonishing. Though a metal, aluminium possesses the structure of a fine stone, has a strong dissolving power and develops, upon use for honing, an exceedingly fine metal-setting substance of greasy feel, while showing great adhesion to steel. The knives, etc., treated with it quickly obtain such a fine, razor-like edge that even the best whetstone cannot produce a like result. Thus, knives which had been carefully set on a whetstone, when magnified a thousand times, still exhibited irregularities and roughness in the edge, while the edge of knives sharpened on aluminium, upon exactly the same magnification, appeared as a straight, smooth line.

A STARCH GLOSS.

A correspondent in the Laundry News gives the following as a very good recipe for making paraffin starch gloss: Melt 2½ pounds of the best paraffin wax over a slow fire. When liquefied remove from the fire to stir in 100 drops of oil of citronella. Have several new pie tins; place them on a level table, coat them slightly with sweet oil, and pour about six tablespoonfuls of the melted paraffin wax into each tin. The pan may be floated in water sufficiently to permit the mixture to be cut or stamped out with a tin cutter into small cakes about the size of a peppermint lozenge. Two of these cakes added to each pint of starch will cause the smoothing iron to impart the finest possible finish to muslin or linen, besides perfuming the clothes.

DIRECT REDUCTION OF OXIDES OF NITROGEN BY THE CONTACT PROCESS.

In a recent number of Comptes Rend. P. Sabatier and J. B. Senderens published the results of experiments in the direct reduction of nickel and copper. It is well known that platinum black brings about a direct reduction of the oxides of nitrogen when mixed with excess of hydrogen. The authors have studied the action of reduced nickel and copper in the same direction.

Nitrous Oxide.—In contact with reduced nickel the reduction of nitrous oxide by hydrogen starts immediately in the cold, with a great rise of temperature. With large excess of hydrogen, nitrogen is the sole product of the reduction. When the proportion of nitrous oxide is increased, incandescence occurs and complex decomposition products are formed, by the reduction of which a little ammonia is produced. In contact with reduced copper no reaction takes place in

* "Le Four Electrique," p. 24.

* Electrical World and Engineer, April 6, 1901.

† Zeitschrift für Elektrochemie, September, 1899. The Mineral Industry, vol. 8, p. 678.

‡ Chemiker Zeitung, No. 31, vol. 26.

§ U. S. Patent 492,767, February 28, 18..

‖ Becquerel's first account dates from February, 1896.

¶ Giesel, Debierne, Schmidt, Meyer, and Von Schweidler should also be mentioned.

the cold, but if the metal be heated to 180 deg. C., the reaction is the same as with nickel.

Nitric oxide in contact with reduced nickel or copper does not react with hydrogen in the cold; but if the metal be heated above 180 deg. C. reduction occurs with the simultaneous production of nitrogen and ammonia. With higher proportions of nitric oxide, incandescence takes place with partial oxidation of the metal.

Nitrogen peroxide, mixed with hydrogen by passing a current of the latter through the liquid peroxide, only reacts in the cold with the metals, forming nickel or copper nitrate; but if the metal be heated to 180 deg. C., reaction with the hydrogen sets in with a considerable production of ammonia. If the proportion of the peroxide be increased, fumes of ammonium nitrite and nitrate are observed, incandescence then ensues, followed generally by a violent explosion. The reaction in the case of nitric acid vapors is exactly similar, owing to the partial dissociation of these into the peroxide and oxygen, ammonium nitrate may condense on the cooler parts of the tube. When the metal is heated to 350 deg. C., no nitrate is produced, but only ammonia and a certain quantity of nitrogen.

The contact properties of reduced nickel and copper in these reactions are very similar to those of platinum black.

THE LIFE-HISTORY OF ANOPHELES MACULIPENNIS.* (MEIGEN.)

By DR. LOUIS W. SAMBON, Naples.

SINCE Ross's discovery that mosquitos of a peculiar kind (genus *Anopheles*) are the alternative and definitive hosts of the parasites of malarial fevers, many papers and articles have appeared on the structure and biology of these dipterous insects. A fair amount of this literature, being the outcome of careful observational work, has added considerably to our previous knowledge. It might perhaps seem fruitless to go over the same ground and necessarily repeat many things which have been already admirably described, but the literature on the subject is so greatly scattered that it has appeared justifiable to publish the following notes.

The study of the life-history of mosquitos imposed itself already twenty years ago, when Dr. Manson discovered that *Culex ciliaris* (Lin.) fostered the larvæ of filaria Bancrofti (Cobbold), but at that time tropical diseases attracted little attention, and Manson's admirable researches failed to rouse the collateral investigations of entomologists. The recent researches by Manson, Ross, Grassi, Bignami and Bastianelli on the *rôle* played by mosquitos in the propagation of malarial fevers, and the discovery made by Grassi and Noè that another hæmatozoon of animals, the filaria immitis (Leidy), is likewise harbored and transmitted by mosquitos, have at length induced a number of medical men and entomologists to study minutely the life-history of these dangerous insects with a view to their possible extermination.

The following notes were collected together with Dr. G. C. Low in the district of Ostia during the fever season of June to November, 1900, and refer to *Anopheles maculipennis* (Meigen), which is the species most common in the Roman Campagna.

In describing the life-history and habits of mosquitos, it is essential to mention not only the genus, but also the species under observation, because species differ not only in structural details, but also in life-habits. Even the same species may show different habits in various localities in accordance with peculiar surrounding conditions. However, in a general way, the life-history of *A. maculipennis* may be taken as a good type to illustrate the biology of malaria-bearing mosquitos. In Europe it is certainly the chief propagator of malarial fevers; hæmamœba malariæ, hæmamœba vivax, and hæmomenas præcox, have all been found in its stomach walls or salivary glands in the corresponding phases of the exogenous cycles.

THE OVUM.

Anopheles maculipennis does not construct, like *Culex pipiens* (Lin.), the characteristic canoe-shaped mass of eggs described by Réaumur, in which about 300 subconical ova are agglutinated together perpendicularly like the cells of bees' combs and wasps' nests, but lays about a hundred eggs, which float horizontally close to each other, forming irregular clusters, which are easily scattered by the wind. The egg of *A. maculipennis* is about 0.7 mm. long by 0.16 mm. broad; it has the shape of a boat, being fusiform in outline, strongly convex below and almost plain above. It is surrounded by a reticulated membrane, which forms a striated rim much wider in the middle third of each side. This membrane is undoubtedly a floating arrangement; it is filled with air, and serves the same purpose as the air-tight chambers along the sides of our lifeboats. The ova are whitish when first laid, and they soon acquire a dark grayish-brown color. They usually hatch on the second or third day, the length of the egg period varying with the temperature. The larva escapes from its eggshell by opening a conical-shaped lid formed by the extremity corresponding to its head.

THE LARVA.

The larva of *A. maculipennis* differs somewhat in appearance according to the stage of development, the most striking difference being the relative size of the thorax which in the full-grown larva becomes much larger in comparison with the other segments of the body. The larva goes through several moultings, and when full-grown measures from 7 to 8 mm. in length. Like the larvæ of all other *Culicidæ* the larva of *Anopheles* foreshadows the form of the imago to a somewhat greater extent than is usually the case with those insects, as flies for example, which pass through a complete metamorphosis. If we imagine the adult *Anopheles* body to be provided with tufts of hairs instead of wings, legs and proboscis, we get a fair idea of the appearance of the larva. Each segment along the sides is furnished with a tuft of branched filaments curved slightly forward. The last segment, besides two tufts of long hairs, projecting backward and upward from the posterior edge of its dorsal aspect, is furnished on the central side with a long fan-like whisk which dips vertically and serves the purpose of a caudal fin. The head is small, globular, and almond-shaped. The eyes are situated laterally at the broadest part, and above them, about the middle of each side are the antennæ. On the dorsal surface between the antennæ is a wide pigmented band with six branched hairs which probably serve to support the head while reversed and tilted upward for the purpose of feeding. The ventral surface of the head is provided with strong biting jaws above which are two wing-shaped bunches of filaments called the whorl-organs. The penultimate abdominal segment carries the spiracles of the large tracheæ and the lower edge of its dorsal aspect slightly overlaps the anal segment. This last segment is armed at the tip with four leaf-like flaps, which are probably both respiratory and locomotory in function and analogous to those of the dragon-fly (odonata) larvæ. The larvæ of *Anopheles* are easily distinguished from those of *Culex* on account of the smaller head, the branching of the lateral hair on each segment, and the absence of a long respiratory tube.

The larva of *A. maculipennis* lies usually extended at the surface of the water with the penultimate segment just awash, so that the breathing stigmata may open freely at the surface. The rest of the body is inclined slightly below the surface, and kept in position among the vegetation of the surface film by the setæ projecting from the anal segment and by the long balancing filaments on the metathorax and first three abdominal segments. The larva may dip the anterior part of its body at various angles with the surface, and sometimes almost vertically, while browsing on submerged particles, but its almost parallel attitude is so constant that it becomes a valuable character to distinguish it at a glance from the large-headed larva of *Culex*, which holds its body obliquely at an angle from 50 to 60 degrees with the surface. *Culex* larvæ may also hold their body parallel to the surface, but they only take this position exceptionally and for a very short time, and even then they can be easily distinguished, because their body is kept at a greater distance from the surface on account of the length of their respiratory tube. A larva which might be more easily mistaken for an *Anopheles* is that of *Dixa*, which has a small head, and likewise may remain extended at the surface of the water, but the usual position of the *Dixa* larva is at the edge of the water close to the bank, where, emerging the middle part of its body out of the water, it assumes the shape of a horseshoe with the concavity toward the water; the last segment with its long setæ resting on the surface, and the head somewhat below and turned upward. The larva of *Dixa* can be easily distinguished from that of *Anopheles* on account of its very small thorax, uniform segments, and larger stigmata.

THE MOSQUITO-PROOF HUT IN THE ROMAN CAMPAGNA.

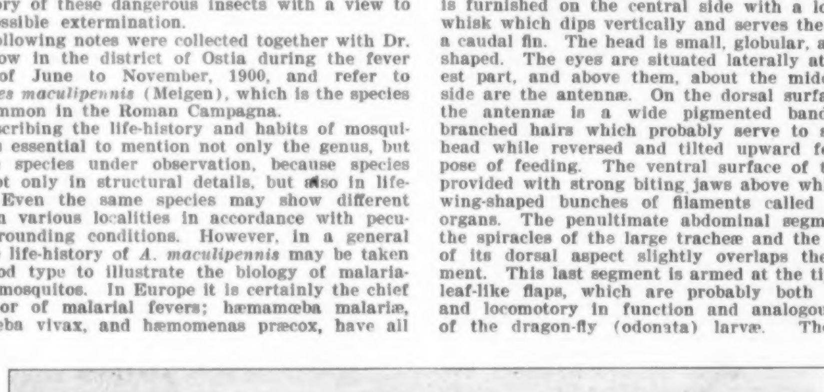
The *Anopheles* larva, if undisturbed, may remain a long while at the surface apparently motionless. If there is any slight movement of the water it may drift gently with the current or turn round its own body axis. It is usually found amid a veritable Sargasso of floating plants and duckweed, resting with its hinder and lateral hairs among the floating vegetation for support. Watching closely the larva which was absolutely motionless, one may see it suddenly twist its head right round. This remarkable movement is accomplished by a rotation of 180 degrees, which suddenly brings the ventral aspect of the head uppermost. In this position the mouth-parts are turned and inclined toward the surface, and the whorl-organs, mandibles, and maxillæ begin immediately to work with extraordinary rapidity. The constant and rapid motion of the whorl-organs creates an eddy or current of water which brings to the mouth the tiny animalcules (cyclopes, cypris, etc.), diatoms and algæ spores on which the larva feeds. After a time, the larva may suddenly stop its whorling-organs and turn its head once more right round, then it may remain quite motionless for a few seconds, or it may dart rapidly away, moving always backward in a curious zigzag manner produced by quick, vigorous, lateral movements of its body. Having settled in a new place, it again suddenly twists its head and resumes its whorling. When disturbed, it often dives to the bottom, displacing itself from among the surrounding weeds by means of a few downward jerks, and then letting itself fall by virtue of its specific gravity, which is greater than that of the water. At the bottom it settles among the sunken *débris* sideways, or with its ventral aspect upward, and remains perfectly still and immovable, simulating death. After a time, which may be considerable, it wriggles back to the surface with a series of jerks, or whip-like movements of its posterior abdominal segments, which are always directed foremost. While floating at the surface, the larva frequently assumes a circular attitude to steady against the last segments of its body any particle on which it may be scavenging, or to clear the spiracles of its breathing tubes.

The color of the larvæ varies greatly, according to food and other surrounding conditions. Those artificially reared in large white earthenware basins with a handful of sand and a few grains of rice at the bottom, were of a light grayish color, while those found in natural pools were mostly olive-green. In some pools within a pine forest and in a stagnant canal containing slightly brackish water many larvæ were found of a beautiful jet black. Very frequently both the green and black larvæ were mottled with silver-white spots on one or more segments along the middle line of the back.

After a period which varies considerably according to temperature, food, and amount of water, the larva transforms to pupa.

THE PUPA.

The pupa differs greatly in appearance from the larva; it strikes one as small compared to the full-grown larva, which therefore appears to have shrunk somewhat at the last ecdysis. Its head and thorax are closed together within a common transparent shell, through which one can also trace the antennæ, the wings and the legs of the perfect insect. The abdominal segments remain free, and acquire a pair of chitinous leaf-like paddles which form a sort of sculling apparatus. A remarkable change is that of the respiratory organs, which do not open any longer on the penultimate segment of the abdomen, but on the thorax by means of two trumpet-shaped tubes. This change in the location of the breathing spiracles brings about a reversion in the attitude of the body, so that the pupa is enabled to float in a position better suited to the liberation of the perfect insect. Dur-



PEASANT HUTS ERECTED ABOVE THE SURFACE OF THE GROUND IN THE HOPE OF AVOIDING MALARIA.

* British Medical Journal.

ing the pupal stage the short biting organs of the larva transform into the long sucking apparatus of the imago, thus, being unable to feed, the head is swaddled up with the thorax. Notwithstanding its clumsy appearance, the pupa is quite as active as the larva, and when disturbed it at once wriggles violently below. However, it rises again almost immediately to the surface, where it usually remains. There is a very striking difference in the sinking and rising movements of larva and pupa; the larva is heavier than the water, and therefore sinks quite easily, but must wriggle very actively to rise again to the surface; the pupa, on the contrary, is lighter than the water, therefore it has to struggle violently to sink, but rises without the slightest effort.

The pupæ of *Anopheles* can be easily distinguished from those of *Culex*. The pupa of *Culex* floats in a more perpendicular attitude than that of *Anopheles*, the posterior edges of its abdominal segments project more and give a serrate appearance to its "tail curve," and the respiratory tubes differ greatly in shape and in the position of their spiracles.

HEAD OF THE MALARIAL MOSQUITO.

The duration of the pupal stage is about two days. When the time of emergence arrives, the abdominal segments are extended backward at the surface, and the pupa case splits longitudinally through the middle of the back. Now the imago gradually extricates itself, using its hind legs to push with and balancing itself with the anterior and middle pairs. The perfect insect usually remains for a few minutes on the surface of the water free from its pupal case, holding up first one leg, than another. It is enabled to stand on the surface of the water just like a pond-skater (*gerris*) on account of the peculiar disposition of its ungual apparatus, but the water must be very smooth. The slightest rippling may wet its wings and drown it. After from five to fifteen minutes it usually takes wing and joins its companions in their mazy dance.

THE IMAGO.

Anopheles maculipennis in its perfect state varies greatly in size. Including the proboscis, it may measure from 7.5 to 10 mm. in length. The antennæ of the female insect are composed of fourteen joints, and are each provided with a circlet of fine hairs of no very great length, those of the male have fifteen joints, and are beautifully plumose, the hairs being much longer and more thickly set, especially on the proximal joints. By means of these striking feathery antennæ the male insect may be easily recognized. The palpi, or maxillary feelers, in both sexes are black and nearly as long as the proboscis. They are clavate in the male. The long palpi of the female *Anopheles* at once distinguish it from all species of *Culex*. The dorsal aspect of the thorax is of a dark gray color, with fine yellowish hairs. It is striped by three longitudinal brown lines. The wings are brownish, with four dark spots. Three of these spots are found extending along one of the veins near the costal vein, while one is somewhat posterior to the last two spots. These spots are due to a thicker accumulation of the black chitinous scales which cover the veins, they are quite apparent to the naked eye and are more conspicuous in the female. The border of the wing is adorned with dark brown scales, which fade off at the apex to a light yellowish tint, and thus form a fairly distinct spot. Behind the wings, on each side of the metathorax, are the halteres, two long-knobbed stalks, which are the rudiments of the second pair of wings. The legs are slender, very long, and of a dark brown color, somewhat lighter at the tips of femora and tibia. The femora of the anterior pair are not enlarged at their base, as is the case with those of *A. pseudopictus* and other species. The abdomen is of a dark-brown color, with long yellowish-brown hair on both the dorsal and ventral aspects.

Anopheles maculipennis is very widely distributed throughout Europe and North America. In Italy it is by far the most common species of the genus *Anopheles*. Like *Musca domestica, Pulex irritans, Cimex lectularia*, and other insects, it has linked itself with man, and is now found in all the houses and stables placed in the neighborhood of its breeding grounds.

BLOOD-SUCKING APPARATUS.

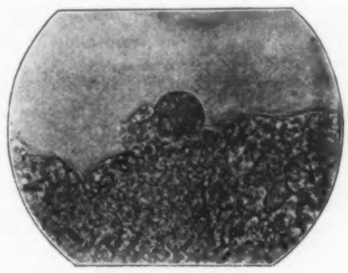
The proboscis or suctorial apparatus consists of an upper lip (labrum and epipharynx) and a lower lip (labium) inclosing a tongue (hypopharynx) and four piercing organs (mandibles and maxillæ). All these mouth parts combine to form the long beak-like appendage which points forward from the head exceeding the length of the antennæ.

The labrum and epipharynx combined form a long, pointed, and grooved instrument, which tapers uniformly from the base to the apex.

The hypopharynx is an equally long, slender, lanceolate rod of transparent chitin, grooved on its dorsal aspect, which, placed in apposition with the upper lip (labrum epipharynx), forms a tube for the ingestion of blood or plant juices. These are imbibed by the œsophagus, which is expanded into a bulb behind a valvular constriction of the pharynx, and acts as a suction pump. The groove which runs along the hypopharynx is connected at the base of the organ with a short salivary duct, which divides into two smaller ducts, each terminating into three tubular glands arranged like the leaves of a trefoil, and situated in the antero-inferior region of the prothorax. These are the veneno-salivary glands described by Macloskie.

The mandibles and maxillæ are four fine-pointed needle-like rods of chitin. The mandibles have slightly broadened lancet-shaped tips with harpoon-like teeth, and the maxillæ have serrated or saw-like outer edges. It is chiefly through the cutting action of the latter that the skin is pierced.

The labium is a long, slightly-tapering, sheathing-organ, which incloses in its groove all the other mouth parts. It is covered outwardly with an abundance of fine hairs and scales, and ends in two fleshy, finger-like appendages called labellæ. These labellæ are furnished with muscles by which they can be dilated or contracted.



BLOOD FROM A MALARIAL PATIENT.

When the female *Anopheles* "bites," the proboscis is pointed downward, and the labellæ are pressed against the skin of the victim. The labrum, the hypopharynx, the mandibles, and the maxillæ are pressed together into one solid boring instrument, like the parts of a trocar. Their common tip is forced down at the angle between the spread labellæ, which serve to hold and direct these clustered parts. While the piercing organs pass into the tissues, the labium bends backward at about a third from its base, and its angle pointing toward the breast of the insect becomes more and more acute with the deepening of the piercing mouth parts. The palpi, which usually lie parallel with the proboscis, are raised and diverged during puncture.

The habit of sucking blood is an acquired habit, confined to the female *Anopheles*. The male insect will at times alight on a hand held perfectly immobile, and will probe about with its suctorial mouth as if inclined to bite, but will invariably fail to do so. In a species of *Culex* (*Culex elegans*) the male is also a blood-sucker, and quite as voracious as its female. The female of *A. maculipennis* will readily bite when inclosed in a test-tube, the open end of which is held in contact with the skin; but it is almost impossible to induce some *Culices* to bite under such conditions. *A. pseudopictus*, like the *Culices* experimented upon would not bite when inclosed in a glass tube. *Anopheles* of both sexes will readily suck up the juices of plants and the females can be kept alive for several months by feeding them with sliced ripe fruit. The habit of sucking blood from a vertebrate is not peculiar to mosquitos only, but is exhibited by various diptera. In some it is common to both sexes, but usually it is confined to the female and may probably be connected with the development of the eggs.

RESTING ATTITUDE.

A. maculipennis usually when resting on a vertical surface sits with its body at an angle of about 30 deg., the angle however varying somewhat according to the position of the legs, the development of the ovaries, and the state of engorgement. This attitude is very different to that of *A. pseudopictus*. The latter, when resting on a wall, seems almost perpendicular to it, because in fact the body of the insect and the supporting surface usually form an angle of about 70 deg. and sometimes one of almost 80 deg.

Mr. E. Austen, the distinguished dipterologist of the Natural History Museum, having noticed this peculiar perpendicular attitude in *A. funestus* (Giles) and *A. costalis* (Loew) at Freetown on the West African Coast, mentioned it in his report of the Liverpool Malarial Expedition as a striking character which might enable anyone to distinguish at a glance these *Anopheles* from the *Culices* of the locality. Unfortunately this character, which held good only for the species of a certain locality, was erroneously interpreted by subsequent writers as a general means of distinction between the *Culex* and *Anopheles* genera.

A character which seems to be truly diagnostic between the *Culex* and *Anopheles* genera is that pointed out by Mr. Waterhouse. In *Culex* the head and thorax form an angle with the abdomen which gives the insect a curious humpbacked appearance; in *Anopheles* the head, thorax, and abdomen are almost in a straight line.

BREEDING GROUNDS.

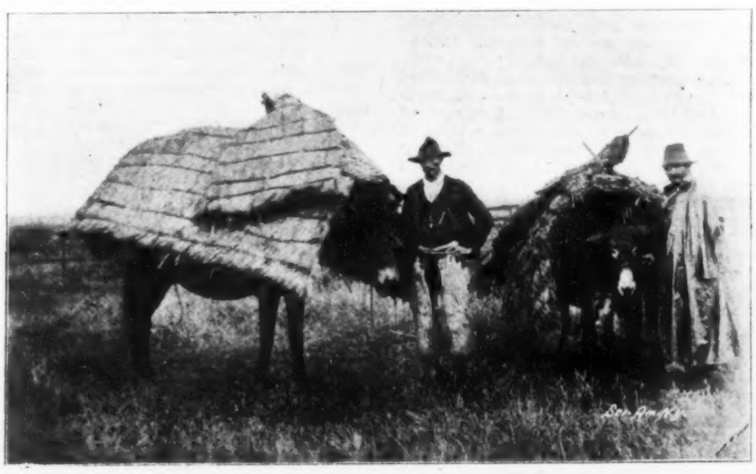
In the district of Ostia *Anopheles maculipennis* was very widely distributed. Its larvæ were found in almost every water collection from the broad emissary of the swamp to a small tub half-full of rain water near the pumping station. The region is being partially reclaimed and is intersected by a vast system of drainage canals which during the summer were stagnant and overgrown with aquatic vegetation. Larvæ of *Anopheles* were found in the majority of these canals, especially on the leeward side of bridges. In the wider canals and larger pools the larvæ were mostly along the banks in the little shallow bays and inlets formed by the union of clumps of reeds. Together with the larvæ of *A. maculipennis* were frequently found several species of *Culex* larvæ, usually *C. penicillaris*, and *C. annulatus*. In a pool within the pine forest of Castel Fusano and in some pools and ditches within the cane jungle beside it were also found larvæ of *A. pseudopictus*. In the brackish water near the closed-up outlet of the emissary, among large brown clumps of floating algæ and seaweed, the larvæ of *A. maculipennis* were very plentiful. In pools entirely covered by duckweed (*lemma*) *Anopheles* larvæ were never found. Larvæ in all stages of development were constantly found from the beginning of June to the end of October, thus showing a continuous, irregular succession of generations.

The number of larvæ in the different pools and at different times varied greatly without any apparent reason. A striking instance of this was that of a small pool in Castel Fusano: On September 20 this pool contained absolutely no larvæ either of *Culex* or *Anopheles*; but a fortnight later it was found to be simply teeming with both in all stages of growth, and on its surface were floating innumerable *Culex* egg-masses.

In all the pools and canals were enormous numbers of frogs, besides swarms of larvæ of dragon flies and water beetles. The emissary and the wider canals contained, moreover, several species of fish, among which the young of gray mullet (*Mugil cephalus*) were innumerable, but the *Anopheles* larvæ occupied the shallows at the edge of the stream, where they were greatly protected by the dense aquatic vegetation.

After torrential rain the number of larvæ remained almost the same in those pools which were under cover of trees and were not liable to be scoured out by the rain, on account of the depth of their banks, but they diminished somewhat in the smaller shallow pools in more open places, and almost entirely disappeared from the emissary after its outlet had been opened and a strong current established by the accumulation of water due to rain and pumping operations.

The adult insects were found in great numbers in the houses and stables of the district. In stables they seemed to rest by preference on the old, dusty cobwebs which heavily curtained the ceilings. In the houses they chose the darkest corners often resting under beds, tables, and chairs, or on dark-colored clothing, but more frequently on the ceiling, especially when these were begrimed with the smoke of winter fires, and well out of the way of danger. In the bedrooms of an inn at Ostia, which had a blue stripe all round their whitewashed ceilings, the *Anopheles* seemed to settle by choice on the dark stripe for protection. It is almost ridiculous how these insects escape detection by those who are not in the habit of looking for them. One may often collect 10 or 20 specimens in a room which after a cursory search seemed to be absolutely deprived of them. The same difficulty is experienced in the detection of larvæ. One must learn first how to look for them, and then how to see them. The best places in which to find adult *Anopheles* are stables, hen-coops, and pigsties. In human habitations they usually occupy the kitchens and rooms on the ground floor. In an old, filthy wineshop in Ostia they could be collected by hundreds toward the end of June. During the summer months both sexes are found in the houses and stables, although the females are always by far the most numerous, but in winter only the



PEASANTS CARRYING THEIR HUTS ON DONKEYS.

hibernating females are found especially in small, dark cellars and cupboards, where they are not likely to be disturbed. During summer, the *Anopheles* do not seem to remain long in the houses and stables. Their number varies greatly from day to day in the same room, and specimens captured in rooms inhabited by malarial patients or filariated dogs are usually found to harbor only the earliest exogenous phases of these parasites. Fresh specimens arrive every evening, gorge themselves on the blood of men or domestic animals, hide for some hours in the darkest corner they can find, and go out again in the morning or the next evening. The female *Anopheles* feed every two or three days; they may oviposit more than once. Their life-cycle is short during summer; those who are unable to oviposit at the end of the warm season hibernate and deposit their eggs in the spring toward the end of March. In some localities a few *Anopheles* larvæ may be found throughout the winter, as if, like in some species of *Culex*, the insects were able to pass the winter in a long protracted larval stage.

In Ostia the adult specimens of *Anopheles maculipennis* were very abundant throughout the month of July, and continued so till the middle of September, when four days of torrential rain greatly diminished their numbers. After this, however, the number again increased, and remained fairly constant till the middle of October, when the weather became cooler and the autumn rains set in. In July and August the *Anopheles* used to appear very punctually a few minutes after sunset and disappear again a few minutes after sunrise. In September and October, when there were several dull and cloudy days, a few stragglers were occasionally seen on the wing throughout the day. They never tried to bite during the day even when disturbed from their resting places.

Anopheles maculipennis does not migrate far from its breeding grounds. It is distinctly local, but it may spread by means of human agency; thus it is often carried long distances with loads of straw and hay among which it may have taken shelter. The possibility of its dissemination by means of coaches and railway carriages was frequently verified. The epidemiology of malarial fevers strongly corroborates the numerous observations of entomologists as to the constant limitation of *Anopheles* to the same areas. The idea that strong winds might carry mosquitos to considerable distances is erroneous. During strong breezes mosquitos invariably take shelter in thick foliage.

The water collections chosen by *Anopheles* for the breeding of their progeny are not so likely to become entirely dried up as those of *Culices*; however, this may happen in some extreme drought, and Nature has provided for it by enabling the larvæ to reach the pupal stage in a relatively shorter period. Experiments made by Prof. Celli show that the larvæ may continue to live in the moist ground for three or four days and that the pupæ continue to develop perfectly well even when the mud has dried up entirely.

A few experiments were made to study the relative value of natural enemies as regards the destruction of mosquito larvæ. Among insect enemies the most destructive to *A. maculipennis* was the larva of a very common and beautiful species of dragon fly, the body of which is of the most brilliant geranium color. Such experiments, however, are of little value, because it is impossible to reproduce *in vitro* the natural conditions. In fact it is quite likely that the larvæ of this dragon fly would have taken other food by preference in their natural breeding ground, as is most reasonably suggested by the size of their curious prehensile organs, usually called "masks," and by their habit of living in the soft mud at the bottom of ponds and ditches. The fact was certainly evident that countless numbers of mosquitos reached their adult stage, notwithstanding the extreme abundance of their natural enemies.

No experiments were made with larvicides; the vast extent of ground covered by innumerable pools, swamps, canals, and ditches, usually thickly overgrown with aquatic vegetation, offered such difficulties that any attempt of the kind would have been hopelessly futile. Undoubtedly there are collections of water suitable to the kerosene treatment, especially in the neighborhood of habitations, but many of these could preferably be filled up, drained, or stocked with small fish.

The great remedy against mosquitoes is the abolition of their breeding grounds; this, of course, is no easy problem. Until then, however, the recent discoveries and experiments show that protection against elephantiasis and malarial fevers may be efficiently obtained by educating colonists in the *rôle* of the mosquito and in the use of mosquito netting.

WEATHER SUPERSTITIONS.*

By EDWIN G. DEXTER.

THE modern science of meteorology, emerging from the mist and darkness of ignorant guess and surmise, has left its path strewn with many a shattered idol. Jupiter Tonans the Thunderer, Pluvius the Rainmaker, and a hundred other weather gods were toppled from their lofty pedestals ages ago, while St. Swithin and his twoscore of saintly colleagues, whose days dominated the weather for the rest of the year, have been quite as surely if more recently dethroned by the delicate instruments and skillful calculations of the modern weather-man.

It is interesting to turn the gaze backward and view in the light of modern scientific research the fallacies that have been corrected and the superstitions that have been lived down. In the centuries that have gone, each event was a portent; Nature's moods were not interpreted in terms of cause and effect. As a consequence, the weather prophets were likely to forecast that which was most wished for, and to lay down as a general, if not infallible law, that which was a mere coincidence of totally independent events.

The enormous extent to which such a foretelling has been carried on, is shown by the vast array of weather proverbs and adages handed down from the past, while the faultiness of their generalizations has been proven by the utter failure of most attempts at their verification. Among the most common of these wise sayings are those which assert a controlling influence of certain days over the weather for considerable periods to follow. The most potent of these special days seems to have been sacred to some particular saint, and perhaps the most powerful of all in this respect was the far-famed St. Swithin, whose wonderful prowess as a rain-maker is shown in the verse:

"St. Swithin's day, if thou dost rain,
For forty days it will remain.
St. Swithin's day, if thou be fair,
For forty days 'twill rain nae mair."

He seems to have been the patron rain-saint of England though standing in the same relation to that country as Saints Medard and Gervais to France, Saint Martin of Boullions to Scotland, and Saint Godelieve to France.

As all these rainy-day saints have days set apart for their special reverence in the early summer, and the weather at that time of the year is unsettled, it is not strange that some one of them has shown quite regularly for centuries the power of the spell cast by him, and thus demonstrated from time to time his right to a place in the category.

Except for St. Swithin's day, perhaps the most berhymed day in the church calendar is Christmas. The condition of snow at that season of the year seems to have been portentous, probably with good reason in its relation to health, as the accepted truth for temperate climate of the line "A green Christmas, a fat churchyard," testifies, but some other wonderful effects have been noted, as—

"Light Christmas,
Light wheatsheaf,
Dark Christmas,
Dark wheatsheaf."

And a peculiar relation between Christmas and Easter:

"A green Christmas, white Easter,
White Christmas, green Easter."

It must be admitted regarding this class of proverbs that they may be built upon some observational knowledge, yet too commonly a coincidence between a day in the church calendar and a characteristic of weather has been put into doggerel verse, and from that time on its truth has been corroborated by a faithful remembering of the occasions that worked well, and an equally as careful forgetting of those that did not.

There are grounds for suspecting that the existence of many of the most "catchy" of all the proverbs is due to the tendency which existed a century or two ago, especially in England, where the crop of sayings seemed to be most prolific, of putting words together in such a way as to form rhyme, even at the expense of truth. A case in point, though not from weather lore, is the epitaph upon a seventeenth century tombstone in an English country churchyard:

"Here lies the body of Thomas Woodhen,
The kindest of husbands and best of men."

Directly beneath is the explanation:

'His name was Woodcock, but it wouldn't come in rhyme."

In the same way, we may wonder what many of our weather couplets would be, if other words had "come in rhyme" better.

Under another class of proverbs, we find an extensive array of authorities, many of whom have gained credence for their prophetical utterances by sheltering themselves under the protecting mantle of astrology or astronomy. These sayings have to do with such commonly accepted beliefs as those of weather changes accompanying changes in the phases of the moon; the equinoctial gales; the potency of "sun-dogs," moon rings and halos.

In the well-known ballad of Sir Patrick Spens, we find this superstition presented by the Knight and Captain:

"Late, late, yestere'en, I saw the new moon
With the old one in his arm,
And I fear, I fear, my master dear,
That we shall come to harm."

While with reference to a halo, our more modern "Wreck of the Hesperus" furnishes another quotation:

"I pray thee, put into yonder port,
For I fear the hurricane.
Last night the moon had a golden ring,
And to-night no moon we see."

Predictions of this class are more apt to contain truth than any of the others given, as they probably exist only under those atmospheric conditions which often precede a storm, and may be considered more trustworthy.

Nearly all of the proverbs of the class we are treating are founded in part upon certain scientific theories with regard to the relative position of sun, earth, and moon, theories which would seem to call for atmospheric disturbances under certain conditions, yet a careful observation of fact has, for the most part, shattered their validity. Even our equinoctial storm is a doubtful quantity.

Richard Inwards * in an interesting article alludes to the fact that De Hoverly examined the tables of the Royal Society for the year 1774, and noted that of forty-six marked changes in the weather for that year, only ten occurred at days of so-called lunar influence, but two of these being at the new moon, and none at all at its full.

M. Flammarion is also quoted as saying that "the moon's influence upon the weather is negligible."

Our popular belief with regard to the equinoctial gales is hard to give up, yet Nature, vol. 30, page 288, gives us the following interesting facts:

"For the years 1870-1884 inclusive, a careful record of all the severe storms occurring in the vicinity of the British Isles was kept tabulated, with the idea of ascertaining their periodicity.

"Although there was shown to be something of a rhythm in their annual occurrence, the results showed no greater frequency at the equinoxes than any other time; in fact, that other periods, especially during the winter months, were much more liable to be accompanied by marked weather disturbances than just this time, the reputation of which is so bad for unseemly behavior."

Another class of weather proverbs having to do with the behavior of animals is handed down to us in almost numberless variety. It would seem as if every animal and plant with which man is familiar had been accredited by some one with special power of prognostication, and boldly championed in verse or prose.

The following poem written by Dr. Janner to a friend includes many, not only of this class, but of others which we have under discussion:

"The hollow winds begin to blow;
The clouds look black, the glass is low.
The soot falls down, the spaniels sleep,
And spiders from their cob-webs peep.
Last night the sun went pale to bed,
The moon in halves, hid its head;
The boding shepherd heaves a sigh
To see a rainbow in the sky.
The walks are damp, the ditches smell;
Closed is the pink-eyed pimpernell.
Hark! How the chairs and table crack!
Old Betty's joints are on the rack.
Loud quack the ducks; the peacocks cry:
The distant hills are looking nigh.
How restless are the snorting swine;
The busy flies disturb the kine;
The cricket too—how sharp he sings!
Puss on the hearth, with velvet paws,
Sits, wiping o'er her whiskered jaws.
Through the clear stream the fishes rise,
And nimbly catch the incautious flies.
The glowworms, numerous and bright,
Illumed the dewy dell last night.
At dusk the squatted toad was seen
Hopping and crawling o'er the green.
The whistling wind the dust obeys,
And in the rapid eddy plays.
The frog has changed her yellow vest,
And in a russet coat is drest.
Though June, the air is cold and still;
The blackbird's mellow voice is shrill.
My dog, so altered in his taste,
Leaves mutton bones, on grass to feast.
And see yon rooks, how odd their flight!
They imitate the gliding kite,
And seem precipitate to fall,
As if they felt the piercing ball.
T'will surely rain, I see with sorrow;
Our jaunt must be put off to-morrow."

These allusions, as the concluding lines indicate, have to do only with an approaching storm, though it is, I believe, noticeable that the animal and plant proverbs deal almost entirely with such predictions and those of the seasons.

All classes of the animal kingdom, birds of the sea, dometic animals including cows, swine, dogs and cats, and hibernating and aquatic animals, seem to have been included within this category of prophets. The acme of credulity is reached in those concerning the leech. This animal is a conspicuous figure in the prognostications, although the smaller fish, by the frequency of their coming to the top of the water, are said to be modest competitors for honors. The prophetic instinct of the leech has been the subject of learned treatises, and at least two whole volumes have been written about him. One of these explains in full a wonderful instrument, which the author and inventor, Dr. Merryweather, called the "tempest prognosticator," and for which he claimed wonderful things. Its success depended upon the supposed activity of the leech before a storm, and was so arranged that the little animal, by his contortions at such a time, was made to ring a bell, and thus give an alarm. He states in his book that he could make a single leech ring the great bell of St. Paul's, and by so doing, allow time for preparations for the coming torrent, and thus be instrumental in preventing much discomfort and pecuniary loss. I do not know how successful the learned Doctor was in introducing this invention to the public, but if his success were at all commensurate with his faith in its efficacy, or his ingenuity in its construction, he must have died wealthy.

A fourth class of proverbs might be included, which has to do with some supposed relation between one meteorological condition and another soon to follow, or of certain conditions existing at one time of day being indicative of immediate change. As an example of the first:

"A storm of hail
Brings frost in its tail."

Or

"If the rain comes before the wind,
Lower your topsails and take them in;
If the wind comes before the rain,
Lower your topsails and hoist them again."

Or of the latter:

"Sun at seven,
Rain at eleven."

And:

"The rainbow in the morning
Is the shepherd's warning.
The rainbow at night
Is the shepherd's delight."

And this, in which we still retain much confidence:

"Evening red and morning gray
Are sure signs of a pleasant day."

As has been already intimated, the great trouble with the weather proverb is its questionable veracity. According to its assertion, things should be what they generally are not. As an example of this, Dr. C. C. Abbott says, of the belief that the opossum before a severe winter burrows deep into the ground, while in expectancy of a mild one, occupies a hollow tree:

"This seems very reasonable, and would pass admirably as a weathersign but for one important circumstance. While you may find one or more in a tree, your neighbor may find as many in the ground. I have known this to be the case more than once. Under these circumstances, meet your neighbor at the fence and compare notes."

"What about the winter?"

But whatever of interest may be connected with these few examples from the vast array of weather proverbs with which the folk-lore of former generations teems, they can hardly be said to have much scientific value. So permeated are they all with the unscientific, so warped is the truth by the desire to make it jingle, that the value is little other than historical, as showing

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

* Nature, vol. 52, p. 577 et seq.

that the vagaries of the weather were in centuries past the object of common observation.

What the effects of one meteorological condition may be upon another we care little, and we must at any rate leave their study to the meteorologist. The influence, however, of those conditions upon members of the animal kingdom, and especially upon man, are of great interest, though not as a means of weather prognostication. In this modern day, when man is being recognized more and more as a creature of his environment, a sequence of personalities, each one varying from others as the conditions of that environment vary, it has seemed strange that of external conditions, the weather has received so little scientific attention. Although there is considerable literature bearing directly or indirectly upon the subject, the bulk of it is principally of interest to the physician, treating as it does of the effect of the weather upon bodily health and disease.

That there is a relation between weather and mental states which can be hardly other than cause and effect, has seemed evident to many. A writer in one of the British magazines * said, in discussing the question:

"There are many persons who are simply victims of the weather. Atmospheric influences play upon them as the wind plays upon the strings of an Æolian harp, with the difference that the harp never utters discord in reply. A leaden sky weighs upon them with a crushing weight, and suggests all manner of unpleasant anticipation. Then the gloomy side of life comes out. The bitter sayings of friends are brought to mind. The old groundwork of forgotten quarrels is remembered; uneasy questions arise with regard to the future. One gets tired of life. A sort of indefinite dread is the general mental influence, a faint continuation of the superstitious fancies which mark the childhood of nations and men."

Who has not at times felt this influence? In all the vigor of perfect health, it may hardly be recognized; but when the vital forces are depleted by the exhausting effects of a long nervous or physical strain, the influence of this phase of cosmical environment is sure to make itself known. Then come those days when everything is sure to go wrong. How inconsiderate are our friends when the east wind blows and the skies are heavy! If we are teachers, how provoking the pupils suddenly become! How dangerously doubtful seems to-day the venture which yesterday, in the bright sunlight, seemed certain of success.

Literature is full of citations which lead us to believe that those who have "felt most" this great world's pulsations have been perceptibly affected by its temperature. Charles Lamb said that nothing less than a sweltering August sky could meet his craving. At such a time, he remarked, he felt himself immortal, "as strong again, as valiant again, as wise again, and a great deal taller."

The poet Moore rejoiced like a song-bird in the sunlight.

> "No joy like this,
> To sit in sunshine calm and sweet.
> It were a world too exquisite
> For man to leave it for the gloom,
> The deep, cold shadow of the tomb."

Byron, too, shows that a bright day had an extraordinary and apparently unusual effect upon him.

"I am always more religious," he said, "on a sunshiny day, as if there were some association between the internal approach to greater light and purity and the kindling of this dark-lantern of our external existence."

He could "bear cold no better than an antelope, and never yet found a sun quite done to his taste."

Shelley loved the intensest ardor of the sun, and wrote many of his best things on the roof of his house near Leghorn, unscreened from its rays. Rousseau, like him, used to bare his head to the sun. As soon as the days began to turn, the summer for him was at an end. His imagination at once brought winter.

Southey, during one of his temporary visits in England, after a long sojourn in Italy, very forcibly expresses himself in a letter to a friend:

"I have lived too long abroad to be contented with England. I miss the sun in heaven, having been upon a short allowance of sunbeams for the last ten days; and if the nervous fluid be the galvanic fluid, and the galvanic fluid the electric fluid, and the electric fluid condensed light, zounds! what an effect must these vile dark rainy clouds have upon a poor nervous fellow like me, whose brain has been in a state of high illumination for the last fifteen months."

Shakespeare himself was keenly observant of the effects of weather. One of the most striking examples of this is in "Romeo and Juliet." The fatal brawl in which Tybalt is slain is precipitated by the effect of the temperature upon the principal actors. Benvolio realized that possibility, and in an attempt to restrain his lively companion, said:

> "I pray thee, good Mercutio, let's retire:
> The day is hot; the Capulets abroad,
> And if we meet, we shall not 'scape a brawl,
> For now, these hot days, is the mad blood stirring."

But his warning was disregarded. As a result, when the Montagus and the Capulets met, they fought. Mercutio lost his life; Romeo was banished for slaying Tybalt; Juliet was forced to take the potion to avoid a hateful marriage with Paris during her lover's absence, and was discovered, apparently dead, by Romeo, who killed himself, and Juliet awakening, completed the tragedy, "falling dead on the body of her lover." Terrible results from the effects of this one hot day.

Although we may not believe that this was alone responsible, for even a hot day could hardly have proved so potent had sluggish blood coursed the Capulets' veins, still investigations which I have recently made † seem to corroborate the wonderful observational powers of the great literary master in matters of weather influences. The records of the police courts of New York city, studied in connection with those of the Weather Bureau, show conclusively that not only on the hot day, but that during certain other meteorological conditions, unknown perhaps by name to the author of "Romeo and Juliet," was the "mad blood stirring." Records of deportment in the public schools, of suicide, of death, of general health, and of the behavior of the insane similarly studied, show unmistakable evidence of a weather influence, and in spite of the fact that it seemed to Samuel Johnson a very sorry thing that "a being endowed with reason should resign his powers to the influence of the air, and live in dependence upon weather and wind," even the most phlegmatic of us must acknowledge the potency of the east wind and the leaden sky.

University of Illinois.

* Once a Week, vol. 19.

† See "Conduct and the Weather," Monograph Supplement, No. 10, The Psychological Review; the Pedagogical Seminary, April, 1898; the SCIENTIFIC AMERICAN SUPPLEMENT, June 3, 1899; Science, August 11, 1899; Appleton's Popular Science Monthly, September, 1899; Educational Review, February, 1900; Nature, February 11, 1900; Annals of American Academy of Political and Social Science, October, 190?; Popular Science Monthly, April, 1901; International Journal of Ethics, July, 1901; Popular Science Monthly, April, 1902.

ALUMINIUM AND ITS ALLOYS.

THE electrolytic process for the extraction of aluminium, which was patented in 1887 by Héroult in Europe and by Hall in America, has resulted in such a great diminution in the cost of production that the price of the metal has fallen from about twenty shillings to one shilling a pound. It is not surprising that, in the early days of the electrolytic industry, this circumstance, combined with the many very valuable properties of aluminium, caused extravagant hopes for its future to be raised.

The experience that has been gained in the past five or ten years has enabled us to form a truer estimate of the value of the metal, though it would be difficult to say even now to how great an industrial importance it may ultimately develop. A very good idea of the present position and prospects of the industry may be obtained from two papers recently published in the Journal of the Institution of Electrical Engineers.* The first of these, by Prof. E. Wilson, gives the results of an elaborate series of tests of the physical properties of a number of aluminium alloys; we shall have occasion to refer to this paper later. The second paper is by Mr. W. Murray Morrison, and contains a description of the British Aluminium Company's works at Foyers and an account of the applications of the metal, its use as an electrical conductor being considered at some length.

The Hall and Héroult processes for the electrolytic extraction of aluminium are practically identical and are too well known to need lengthy description. The aluminium is obtained as the result of the electrolysis of alumina dissolved in melted cryolite ($6NaF.Al_2F_6$). The electrolysis is carried out in a carbon-lined crucible, at the bottom of which the separated metal collects, the liberated oxygen combining with the carbon of the anode and passing off ultimately as carbon dioxide. It is interesting to note that, whereas the specific gravity of solid aluminium is less than that of solid cryolite, in the fused condition this order is reversed; but for this the process in its present form would be unworkable. Some figures showing the cost of production by the Héroult process are given by Mr. Blount in his "Practical Electrochemistry," as follows:

Cost of power....	2.2	pence	per lb.	of aluminium.
Cost of alumina..	4.0	"	"	"
Cost of electrodes.	2.0	"	"	"
Cost of labor, etc.	2.0	"	"	"
Total cost......	10.2	"	"	"

It is probable that this estimate is somewhat high, but it is sufficient to show that the cost of power is a very important item, which explains the necessity for the use of water power. The cost of power per pound is higher than in any other electrolytic manufacture; it forms, it will be seen, about one-fifth of the total cost; in the manufacture of calcium carbide, another electrochemical industry requiring cheap power, the ratio of cost of power to total cost is about 1 to 7.5.

The product of the electrolytic furnace is very pure. According to Mr. Morrison, commercial aluminium is 99.5 to 99.6 per cent pure, the impurities being iron (about 0.25 per cent) and silicon (about 0.17 per cent). A sample of pure commercial aluminium analyzed by Prof. Wilson contained 0.31 per cent Fe and 0.14 per cent Si, which agrees pretty closely with Mr. Morrison's figures.

This standard of purity has only been gradually attained, and we may hope for further improvement. The purity is a matter of importance, as it affects the value of the metal as an electrical conductor in two ways, for impurities not only lower the conductivity, but also increase the liability to atmospheric corrosion. The evidence as to the power of aluminium to withstand atmospheric influences, especially in towns or places where the air is bad, is somewhat conflicting, but on the whole it seems that the metal is fairly satisfactory in this respect. The thin film of oxide which immediately forms on the surface of the metal in air acts as a protective coating. Mr. Morrison quotes an interesting illustration of the tenacity of this oxide film; if the metal is cast into a mould and allowed to overflow, the film of oxide adhering to the molten metal that has run over acts as a siphon tube, and will siphon out a considerable quantity of the aluminium.

The two most marked characteristics of aluminium, on which its principal applications depend, are its high affinity for oxygen and its low specific gravity. The former of these properties causes aluminium to play a part of considerable importance in the metallurgy of other metals. Thus in the casting of steel, iron, brass, etc., the addition of a small quantity, two to five pounds per ton, of aluminium is found greatly to improve the finished casting; the aluminium, by combining with the occluded gases, reduces the blowholes and renders the metal being cast more fluid and ultimately more homogeneous. Though the actual quantity used in this way is but a small percentage of the metal to which it is added, the total consumption of aluminium for this purpose is very large. A second use for aluminium depending on the same principle has been devised by Dr. Goldschmidt for producing high temperatures, and has been applied to the welding of iron rails, pipes and so forth. A mixture of iron oxide and finely divided aluminium is used, and is ignited by means of a magnesium ribbon; a very high temperature is immediately reached by the oxidation of the aluminium at the expense of the oxygen of the iron oxide. This process, having been only lately introduced, has not yet become of much commercial importance, but is full of promise.

The extremely low specific gravity (2.6) of aluminium has naturally resulted in its use in cases in which weight is a drawback. Thus in naval and military equipments, in motor-car construction and like applications, the metal already finds considerable and increasing employment. For cooking utensils the use of aluminium is steadily increasing; the metal is eminently suited for this purpose, as, apart from its lightness, it is a good conductor of heat, is not liable to deteriorate in use and gives rise, if dissolved, to perfectly harmless compounds. Applications of this kind may seem small individually, but in the aggregate they constitute no mean field for the metal to capture.

The chief drawback to aluminium is its low tensile strength, which, for the cast metal, is only from five to eight tons per square inch; but for this weakness its utility would be enormously increased. A certain amount of improvement can be effected by alloying a small quantity, generally less than 10 per cent, of some other metal, such as nickel or copper, with the aluminium. The specific gravity of these alloys is only slightly higher than that of the metal itself, but the tensile strength may be made two or three times as great. Exceedingly valuable data relating to a number of these light alloys are contained in the paper by Prof. Wilson to which reference has been made above. It is impossible to enter at all fully into the results obtained by Prof. Wilson, as the paper is itself so condensed as to be little more than a summary, but a few of the more interesting conclusions may be briefly tabulated. In the accompanying table is shown approximately the effect of alloying different metals on the conductivity, specific gravity and strength of aluminium.

Aluminium.	Principal Impurity.	Other Impurities.	Specific Gravity.	Conductivity.	Limit of Elasticity: lb. per sq. in.	Breaking Load: lb. per sq. in.
99 5 per cent.	Commercial aluminium	Fe (0.31), Si (0.14)	2.715	61.5	19,375	28,200
98-97 "	Copper, 1.6-2.6 per cent.	Fe (0.4), Si (0.4)	2.75	51	33,000	41,000
98-97 "	Zinc, 1.2-2.4 "	Fe (0.4), Si (0.43), Cu (0.2)	2.74	56	20,500	28,000
98-96 "	Nickel, 1.2-2.2 "	Fe (0.6), Si (0.35), Cu (0.1)	2.745	52.5	22,000	36,000
98.3 "	Iron, 1.2 "	Si (0.4), Cu (0.1)	2.73	57.1	20,300	31,300
97 "	Copper, 1.1 " / Nickel, 1.3 "	Fe (0.43), Si (0.37)	2.75	49.7	36,600	45,900
Hard drawn copper			8.9	98	28,000	64,000

Aluminium is now finding considerable employment as a substitute for copper as an electrical conductor, especially in America, where it is used to a large extent in connection with the transmission of power over long distances. One of the most important of these installations is the transmission of 12,000 horse power from the Snoqualmie Falls to Seattle and Tacoma, a distance of more than forty miles. In this scheme an alloy of aluminium with 1½ per cent of copper has been used, the lightness and strength of this alloy enabling spans of 150 feet to be made with safety. A great saving in the number of poles is thus effected, which is one of the principal advantages gained. Numerous other important transmission schemes might be quoted in which aluminium is used, or in which it has been decided to use it. As has been just pointed out, the use of aluminium effects a great saving in the number of poles required; it also involves dealing with a much smaller weight of conductor, and is, finally, cheaper than copper. In round numbers, for equal conductivity, the section of an aluminium cable is one and a half times that of a copper one, the weight is half and the tensile strength three-quarters. It is the decreased weight which, in spite of the smaller tensile strength, allows longer spans to be used, and this effect can be made more marked by the use of a suitable alloy possessing increased strength without much diminished conductivity or much higher specific gravity. Mr. Morrison gives an interesting table showing the variation, according to the price of copper, in the price per pound that can be paid for aluminium for equal conductivity and equal cost. From this it appears that with copper at its present price of about tenpence per pound, twenty-one pence per pound could be paid for aluminium, which is two or three pence above its market price, showing that aluminium conductors are cheaper.

It is to be noted that the above remarks apply only to bare conductors. Where insulated cables are needed for low tension work the increased diameter of an aluminium conductor involves increased cost in insulating material; moreover, with lead-covered cables the increased weight of the lead would almost, if not

* "The Physical Properties of Certain Aluminium Alloys, and Some Notes on Aluminium Conductors," by Prof. E. Wilson. (Journal I.E.E., vol. xxxi, p. 321.) "Aluminium: Notes on its Production, Properties and Use," by W. Murray Morrison. (Ibid. p. 400.)

quite, cancel the decrease in weight gained by substituting aluminium for copper. For high tension cables it is possible that aluminium may in some cases be cheaper than copper. Thus in a paper by Mr. M. O'Gorman* it is shown that increasing the diameter of the conductor may produce such a diminution in the depth of insulation necessary as to lessen the total price; in such circumstances a tubular copper conductor, or an aluminium conductor, could be used with advantage. There seems, therefore, a possibility that aluminium may some day successfully invade the field of insulated cables, hitherto regarded as peculiarly the property of copper.—Nature.

PURIFICATION OF FEED-WATER FOR LOCOMOTIVES.

The inconveniences attending the use of hard water for the supplying of boilers have long been recognized. Such water gives rise to deposits that have to be removed by chipping. As these deposits are generally bad conductors of heat, the fuel is not well utilized and the vaporization is irregular. When a boiler covered with scale becomes overheated, the plate may be raised to a red heat; and if, through a fissure, the water comes into contact with the super-heated metal, an explosion may occur. Calcareous water, moreover, produces corrosions that sometimes make the metal become dangerously thin.

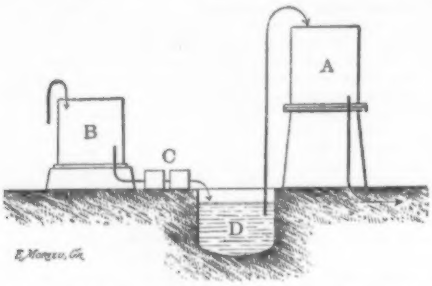


Fig. 3.—INTERMITTENT WATER PURIFIER.

Such inconveniences, which are very marked in locomotives, have led the various managements of railroads to study methods of remedying them. The results of these studies, furnished on the occasion of the last Exposition, we shall briefly recall.

In the first place, what are the injurious substances met with in water? Primarily, materials in suspension, especially organic ones; and secondarily, dissolved salts, which are generally carbonates or sulphates of lime and magnesia. Water is also injurious to boilers if it contains chloride or nitrate of magnesium, both of which are very corrosive.

The carbonates of lime or magnesia are eliminated by means of lime water or caustic soda. The sulphate of magnesia is precipitated by the addition of caustic soda, which, through motives of economy, is sometimes replaced by carbonate of soda.

It is only quite recently that it has been proposed to correct the bad quality of water in stationary plants. Railroad companies were formerly, and often are still, content to supply locomotives with impure water, while at the same time endeavoring to prevent, as far as possible, scale from forming. The methods employed for this purpose are exceedingly varied.

In the first place, there may be added to the water a little soda or carbonate of soda, which precipitates the salts of lime in the form of a sediment. Certain companies simply add the solution to the water in the tender.

One substance that is very much employed for the prevention of incrustations is extract of *Quebracho colorado*, a South American wood. The South American, as well as a certain number of French railroad companies, have pointed out the excellent results obtained by this method. An analogous result is obtained with Campeachy wood, which the French State railroads are employing with success. Some lines, moreover, use a mixture of Campeachy and Quebracho, in conjunction, oftentimes, with a solution of carbonate of soda. Extract of chestnut seems to have given analogous results.

A Belgian company diminishes the adhesion of the deposits by putting into the boiler, after each washing, about two pounds of potatoes. For preventing the adhesion of the scale, the use of petroleum has likewise been tried. Zinc, too, has long been used for the same purpose. This forms with the metal of the boiler a voltaic couple, which sets hydrogen free at all points of the boiler, and thus prevents the adhesion of the scale. As regards locomotives, the experiments have been quite numerous, but have given only very mediocre results.

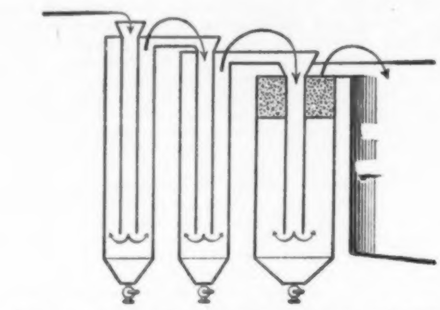


Fig. 4.—THE BERANGER-STINGL WATER PURIFIER.

Upon the whole, all the processes above commended are mere palliatives, and none gives completely satisfactory results. In order to purify water, in a complete and rational manner, stationary purifiers must necessarily be employed, and if the number of these is not very great on locomotives, the fact is doubtless due to the cost of installation and expense of purification per cubic foot of water. Such expense, however, is very variable, since it depends at a given moment upon the price of the reagents employed and the quantity that is necessary according to the analysis of the water to be tested. It is therefore not astonishing that the cost of purification may vary currently from a small fraction of a cent up to 10 cents per cubic foot.

The type of apparatus employed in the treatment may also have a notable influence upon the cost of the operation, either through the interest on the capital invested in cases of costly apparatus, or through the expense of manual labor in apparatus that are not completely automatic. The first idea was to construct what are now called intermittent apparatus, that is to say, apparatus in which the operations are performed in succession. Thus in the type shown in Fig. 3, the reservoir, *B*, is filled with the water to be purified along with the reagents. The water passes through filters, *C*, into a basin, *D*, whence it is pumped up into the supply reservoir, *A*. In this process, the reagents and the sediment have to be put in and removed respectively by hand.

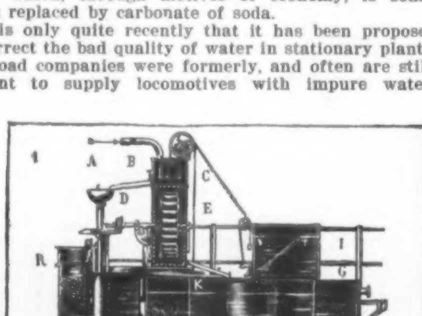


Fig. 1.—VERTICAL SECTION OF THE DESRUMEAUX AUTOMATIC WATER PURIFIER.

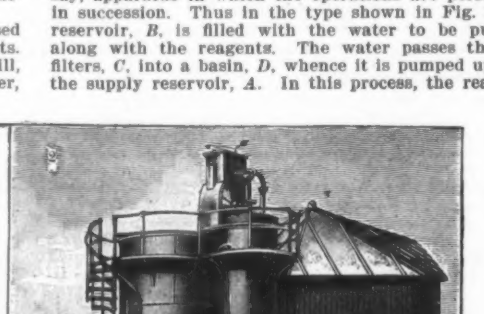


Fig. 2.—GENERAL VIEW OF THE DESRUMEAUX PURIFIER ATTACHED TO A RAILROAD WATER TANK.

In recent years the use of continuous apparatus has been notably developed. Among those most employed may be mentioned the following:

The Gaillet Apparatus.—This consists of a rectangular box containing shelves. The water to which the reagents have been added enters at the bottom and rises to the upper part while depositing the precipitate formed. The space between the shelves increases from the bottom to the top of the apparatus. The velocity thus continues to increase and this facilitates the deposit. A filter placed at the upper part retains the last particles carried along, and the deposits are drawn off through a mud-cock.

The Beranger-Stingl Apparatus.—As shown by the diagram in Fig. 4, this consists of a series of connecting tubes. The water descends through the interior tube and ascends through the annular space surrounding it, depositing in the mean time the greater part of the precipitates. It then passes to the following tube and receptacle, where the same thing occurs. Mud-cocks are arranged at the bottom for drawing off the sediment.

The Desrumeaux Apparatus.—Fig. 1 shows the general arrangement and mode of operation. The water enters the distributing compartment, *B*, through the pipe *A*, and the greater portion of it descends through the regulatable valve, *C*, into the purifying apparatus. A very small portion flows through the valve *D* into the apparatus to the left in which the lime water is prepared. The lime to be slaked and to form milk of lime is placed in the compartment *R*, whence it falls into the saturator *J*. The solution of lime is drawn off through the channel *K* into the reaction column *M*, where it meets with the water to be purified and a solution of carbonate of soda (or some other soluble reagent) coming from the reservoir *G*. In order to proportion this latter reagent it is necessary to assure a constant flow. This is effected by taking the liquid through the distributing float *I*.

The water mixed with the reagents descends through the column *M* and ascends again along helicoidal plates, *N*, so arranged that the precipitates remain adherent to them. The purified water ascends to the upper part and traverses the filter *Q*.

The shift of the lime saturator is set in motion by the wheel *E*, which is actuated by the fall of the water to be purified.

Fig. 2 shows the application of a purifier of this kind to a feed-water reservoir.

Among other apparatus employed, which we cannot describe here for want of space, may be mentioned those of Howatson, Clark, Dervaux and Archbutt and Deeley.

The Dervaux system is a process of filtering after chemical treatment. In the Archbutt-Deeley process, the recently precipitated substances are mixed by a current of air with the substances derived from preceding operations, the tenuous portions adhering to the portions already precipitated. In this way the process is pretty rapid, and the apparatus is capable of furnishing quite a large output.—Translated from La Nature for the Scientific American Supplement.

CONGRESS FOR PROTECTION AGAINST HAIL IN LYONS.

Consul J. C. Covert, of Lyons, sends the following:

The official report of the International Congress for Protection against Hail has just appeared. I give below a brief synopsis:

After recording the names of the members of the congress—scientists and farmers from nearly all the great nations of the world—the volume reviews the history of efforts in the direction of protection against hail, which became widespread in France, by means of firing cannon, toward the close of the eighteenth century. In 1891, the defense was taken up with earnestness and carried to its present point. In that year, General Dyrenforth undertook to produce rain by the use of cannon, and Signor Louis Bombicci, professor at the University of Bologna, inaugurated a similar process for protection against hail. In 1896, Albert Stieger, burgermeister of Windisch Feistrits, is said to have turned a hailstorm into a fall of fine rain by the detonations from a number of mortars. In 1899, a meeting was held at which the farmers reported the use of 2,000 grelifuge cannon in Italy. A year later, from 10,000 to 12,000 cloud-firing stations were represented at the congress of Padua. At this congress, it was unanimously voted to continue the war against hail, on condition that it should be done systematically.

The Department of the Rhône, in which this consulate is situated, claims to have established the first cloud-firing post. It now has 834 cannons, covering 45,000 acres of vineyards. Everywhere, there are officers who direct the firing. Signals are established—the hoisting of a flag, the ringing of a bell, or the firing of a cannon. Eight different kinds of cannon are employed, besides the old mortar, which takes a charge of 2 pounds of powder. Of these cannon, 8 are French and 2 are Italian inventions.

In the Beaujolais district, in 1900, it was reported that 21 storms were cannonaded before the wine-making season. On the 2d of June, 10,000 shots were fired during one storm, and the report says "the firing protected us from the hail." At least, all were of the opinion that the electrical discharges ceased after the firing commenced.

"There was no more heavy thunder; it was only heard rolling in the distance. Under the action of the firing, the thick black clouds were rapidly torn to pieces and dispersed. It is true that the wind continued very high, but it did only a little harm to the tender branches of the vine, while on the neighboring lands, from which the storm came, it caused great damage. . . . It is to be presumed that we diminished its force. A number of persons declare that a few soft hailstones fell, accompanied by drops of whitish, starch-colored water."

Upon the whole district protected, there fell but a small shower of water, equivalent to an ordinary sprinkling. Farther off, in the direction of Lyons, the clouds formed anew. At Lucenay, the rain was very abundant and near St. Germain it became a torrent. The water washed deep ravines in the fields in several places. In this place there was no fall of hail. Some of the communes at Beaujolais, north of the field covered by the cannon, were visited by a fall of hail about 1 kilometer (0.62 mile) wide.

The following is the language employed in the report:

"The observations made on June 10 and 11 permit us to form a positive judgment of the efficacy of the firing. It is, in fact, certain that where the cannon have been used in time, the most satisfactory results have been produced."

* "Insulation on Cables," by Mervyn O'Gorman. Journal of the Institution of Electrical Engineers, vol. xxv, p. 608.

In the general conclusions adopted by 18 hail-firing societies, it was stated:

"No hail fell in the whole length of the field protected by the Society of Villefranche, except on the 28th of July. On that day a little hail fell on a spot that was not protected by cannon."

It was almost always observed that the firing stopped the wind or diminished its force considerably, perforated or cleared away the clouds, entirely or very largely stopping the electric discharges above the protected zone; the lightning and thunder raging only outside of it.

One commune reports that the impression of the people is unanimous in favor of the cannon.

"We declare that during the last two years—that is to say, since our organization—no hail has fallen, while it has fallen in the neighboring communes, but without great intensity."

DRAWING A PARABOLA.*

THERE is a simple method of drawing a parabola which seems but little known to engineers. It is done by folding a sheet of paper in the following way: The distance from the focus to the directrix of the required parabola being given, a point is selected at this distance from one edge of the paper. The point is to be focus, and the edge of the paper, the directrix of the parabola. The paper is now folded over so that some point on the directrix edge touches the focus, as shown in Fig. 1, and the fold is well creased as shown in Fig. 2. This is repeated over points a short distance apart all along the directrix until the inner edge of the folds presents a continuous curve as shown in Fig. 3. The rationale of this method is obvious from the well known property of the parabola, that the normal to the directrix from any point on the curve equals the line joining that point to the focus. If the focus be taken equally distant from the two edges of the paper which are at right angles to the directrix, the two arms of the curve will be the same, whereas if the focus be on one of these edges, there will be only one arm. The best paper to use is the glazed variety as it shows the creasing to advantage. A. M.

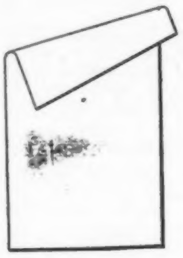


FIG. 1.

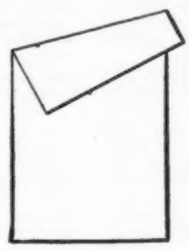


FIG. 2.

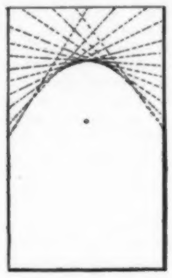


FIG. 3.

HOW TO MAKE A WATER MOTOR.*

By R. E. DAVALL.

THE motor which forms the subject of this article was designed to obviate the use of expensive tools, seldom within reach of the average amateur mechanic. Only a few cheap tools are necessary to turn out a good strong motor.

It is best to begin by making the wheel. The necessary materials for this are a 4 or 5 inch piece of ¼-inch steel rod, for the shaft, a small piece of close-grained wood ¾ of an inch thick and 3½ to 4 inches square (redwood is preferable, as it is not easily split or warped). Eight inches of ⅜-inch (outside diameter) brass tubing, and eight ½-inch flat-headed brass screws.

Start the work by sawing a 3½-inch circular piece from the wood. In its center bore a ¼-inch hole, and mount the piece securely on the shaft. To do this get two pieces of sheet zinc or brass 2 inches in diameter, punch or bore a ¼-inch hole through the center of each, and slip them over the shaft, one on each side. Secure the pieces to the wood by means of eight ½-inch brass brads, four in each side, as shown at Fig. 3 *B*. Then solder the zinc pieces to the shaft. The next operation is to take the shaft with its wheel to a wood-turning shop, and have the wood turned down to a diameter of 3 inches; and also a square groove turned in its face, ⅜ of an inch wide by 3-16 of an inch deep, which can be done for a small sum. Now take the brass tubing and grip about ¼ of an inch of it in a vise. Screw up the vise until the part of the tubing gripped is flattened, care being taken to hold the tubing perpendicular to the jaws of the vise. With the aid of a fret, file, or hack saw, cut this flattened portion off at a slight angle, to the length of ⅞ of an inch, as shown in Fig. 1. Bore a ⅛-inch hole through the center of the tubing as shown; grip the remaining length of tubing and flatten it as before. Continue the operation until eight of these brass pieces are completed. These are to be distributed around the wheel in the groove at equal distances apart and fastened down with the ½-inch screws already mentioned. It will be found that the flattened portion is about ⅝ of an inch wide and the groove but ⅜ of an inch wide, so that the brass cups will not fit. Consequently it will be necessary to do some widening with a penknife to allow the flattened portion of the cup to fit snugly down into its place. So much for the wheel.

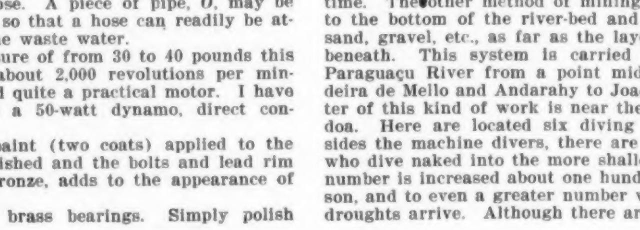
The next thing that occupies our attention is the casing. This is constructed from lead or type metal (whichever is the easier to get), and two pieces of galvanized iron 1-32 of an inch thick. The outside rim should be cast to the shape and size as indicated in the shaded portion Fig. 2. Procure a piece of 1-inch wood sufficient in size to make a mold for the casting; lay off the shaded portion, which can be cut out with a compass saw, and the part marked *X* rounded to a diameter of ¾ of an inch, forming the outlet for the water. On the flat wooden surface lay a thick newspaper; on it place the mold, which is fastened down with wire brads. Care should be taken not to leave any spaces between the newspaper and the wooden mold. Otherwise melted metal will escape. The metal should now be melted, but not allowed to get too hot. Gently pour it into the mold until it reaches a trifle above the level of the wood. With a piece of cigar-box wood smooth the metal down well, so as to get good square edges. Cease handling the metal as soon as it begins to set, because it is liable to crack and spoil the casting. When it is cold it can be removed. The sides can now be cut from galvanized iron to the full size and outside shape of the casting. Place the two pieces of sheet metal together, and bore a ¼-inch hole for the bearings, as shown in Fig. 3 *S*. With a small soldering iron solder one side on the casting permanently. Two ½-inch pieces of brass tubing, ¼ inch diameter inside, should be soldered into the holes of the side pieces, so as to increase the bearing surface, the holes being only ¼ of an inch in diameter. It will be necessary to enlarge them to admit the pieces of tubing, which can easily be accomplished by the aid of a three-cornered file. These pieces of tubing project about 3-32 of an inch on the inner side, and serve to keep the wheel from touching the sides when revolving. One-eighth-inch holes should now be bored through the casting about 1½ inches apart, around the edge. Nineteen of these holes will have to be bored. Through the holes place 1½-inch stove bolts.

Bore two ¼-inch holes at *N*, Fig. 3, for the purpose of bolting to a base-plate; also a ⅛-inch hole at *M*, in such a way that it points directly at the center of the lower cup, *C*. Before putting on the remaining side, interlace around the bolts a piece of ⅛-inch rubber tubing, or better still a piece of very fibrous cord, well rubbed with graphite, as shown at *T*; this makes the case watertight, except at the outlet, *O*. The wheel can now be inserted, with the lower cup pointing toward the jet, *J*, and bolt down the remaining side. The motor is then practically finished except the water jet, *J*, which is made of about three feet of garden hose, and the nozzle, which is made out of an oil can, 4 inches long, placed into a hose coupling and secured in place by means of lead so that it will appear as in Fig. 4 *B*. *A* shows the jet, *B*, inserted in the end of the hose, and held in place by a stout cord or piece of wire wound around the hose. A piece of pipe, *O*, may be fitted into the outlet, so that a hose can readily be attached to carry off the waste water.

With a water pressure of from 30 to 40 pounds this machine will make about 2,000 revolutions per minute, and will be found quite a practical motor. I have made mine to drive a 50-watt dynamo, direct connected.

A very dark red paint (two coats) applied to the sides, afterward varnished and the bolts and lead rim gilded with a gold bronze, adds to the appearance of the motor.

Do not paint the brass bearings. Simply polish them. The wheel may be painted to insure against probable warping. If the foregoing directions are carefully followed, the result will be a well-made model of good appearance.



HOW TO MAKE A WATER MOTOR.

BRAZILIAN DIAMONDS AND CARBONS.

DIAMONDS are said to have been first found, in the State of Bahia, in 1821, in the range of mountains known as Serra do Sincorá, but not until 1844—when José Pereira do Prado, who was traveling from that region to Bahia City, and camped for the night on the bank of the Mocuge, a small tributary to the Paraguaçu River, and there, by accident, found a quantity of diamonds—was any impetus given to mining for the precious stones. As soon as it became known that diamonds in quantity had been found, great numbers of people set out for that region, and at the site of the discovery, S. Joao do Paraguaçu, otherwise known as Santa Isabel, was founded, and has continued to be one of the chief diamond centers. The State divides the diamond region into fourteen districts, namely: Lençoes, Andarahy, Chique Chique, Santa Isabel Cravada, Chapoda Velha, Paraguaçu, Sincora, Lavrinha, Campestre, Morro do Chapeo, B'om Jesus, S. Ignacio and Cannavieras, the region taking its name from the town which forms its center. A better division would be into two sections in accordance with the geological formation and position—one in the center of the State and tributary to the Paraguaçu River, and the other in the southern portions of the State along the Pardo River. By far the most productive section is that first mentioned under this classification. It has been almost continuously worked since the date of its discovery in 1844, and it continues to be productive, though the number extracted has of late been decreasing on account of the lack of tools and machinery. Prior to the discovery of the South African mines, this section was the greatest producer of diamonds, and prices were high, but the output in Africa tended to decrease interest in the Bahia mines.

According to Consul Furniss, of Bahia, diamonds are first encountered in the bed of the Paraguaçu River, 103 miles from Cachoeira, at a place called Joao Amaro. They are found from there up to the source of the river, but from Joao Amaro to Andarahy in very small quantities, doubtless due to the difficulty in mining them, as they seem to occur only in the river bed. The most productive area is in the foothills to the east of Sierra das Labras Diamantines, particularly along the many small streams tributary to the Paraguacu River, with the towns of Santa Isabel, Chique Chique, Andarahy, and Lençoes as centers. The geological formation of the region is very interesting, and shows that at some time in the history of the world, the mountains were thrown up by a hot mass of stone, and the diamonds there found are the carbon which by great heat and pressure crystallized. A considerable portion, for lack of proper conditions, failed to crystallize, and is now encountered in hard, blackish masses of irregular shape, known as carbon. The method of mining differs in the different sections. In the most productive one, the work is of two kinds: removing the surface disintegration and that in the gullies, crevasses, and beneath the more accessible stones, or mining by tunnels between the stones into the pockets of the mountains, and taking out the "cascalho" found there. Cascalho is the diamond and carbon-bearing material which consists of soil, sand, broken, or disintegrated stone. The cascalho is usually collected until toward the week's end, and is then laboriously washed, either by pouring the masses into sluices or ditches of running water and agitating it with a hoe, or by placing small quantities in large wooden basins and washing it in water. In the first instance, the object is to wash the soil and heavier particles away, arrangements being made to impede the heavier masses, and consequently the diamonds and carbons. The part remaining is carefully washed in the large wooden basins and the rocks picked over by hand. The miners are so accustomed to the appearance of the desired stones, that in spite of the facts that there are ordinary stones which closely resemble them, they can wash and finally sort a very large quantity of diamond-bearing material in a short time. The other method of mining consists in diving to the bottom of the river-bed and removing the silt, sand, gravel, etc., as far as the layer of clay or stone beneath. This system is carried on mostly in the Paraguaçu River from a point midway between Bandeira de Mello and Andarahy to Joao Amaro. The center of this kind of work is near the village of Tamandoa. Here are located six diving machines, and besides the machine divers, there are about twenty men who dive naked into the more shallow places, and this number is increased about one hundred in the dry season, and to even a greater number when the periodical droughts arrive. Although there are perhaps as many as 5,000 people who work more or less in the mines, they do not work systematically, and only endeavor to take out such cascalho as can be easily removed. Their only implements are a hoe, a crowbar, a hook-shaped piece of metal about two fingers in width and about eight inches long, mounted on a pole three or four feet in length, sometimes a hammer and a hand-drill and two wooden basins, one of small size to carry the cascalho to the water's side, and a large basin with which to wash. Now and then ordinary powder is used to remove a refractory ledge of rock.

According to law, all diamond and carbon-bearing lands belong to the State. It is possible for a person of any nation to take out a claim, by complying with the regulations. These require a claimant to make a general description in writing of the portion desired —which may be not more than 578,864 square yards,

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

or less than 34,732 square yards—and to file application for the same at the office of the director of diamond mines at Lencoes. Anyone mining without a license or lease, subjects tools, and such stones as may be found, to confiscation, the State giving one half of the value of the confiscated property to the informer. Besides the claims leased in the regular way, there are various concessions which have been granted by the State to private persons and companies, but in all cases to Brazilians, except one concession to a French company at Cannavieras. In the Paraguacu region there are six such concessions, which differ in size, but average about nine square miles, and from which the State receives sums ranging from £25 to £380 a year. In each town of the mining district there are buyers who represent the five Bahia city firms which are in the carbon and diamond business. These buyers are furnished with large quantities of money, and are advised by each mail and frequently by special messenger as to the highest price they can give, these prices being regulated by cable from abroad. While the prices in the main are even, there is often competition for a good specimen, and a miner usually goes the rounds and sells to the one offering the best price. The output of carbons for the district now averages about 2,500 carats a month. Unless there are improvements in mining, and modern methods and machinery are introduced, the output will undoubtedly decrease year by year while the demand is constantly increasing. Immense quantities of carbons are there, but it will take well directed companies with large capital to take them out, and there are little chances for small operators. Carbons are classified as porous, or crystalline and good. The first variety is being bought from the miner at the present time at half the price of the good stones which sell at £5 per carat if the stone is larger than three-fourths of a carat, and at thirty shillings per carat for stones of from one half to three-fourths of a carat, with which are mixed globular diamonds. For very large carbons the price is usually a small amount less per carat, as these have to be broken up for the trade. The largest carbon ever encountered was found in the Lencoes district in 1895 on the ledge of a mountain which had been worked some time before. It weighed 3,150 carats, and was purchased from the miner for £3,200, one-fourth of the price going to the owner of the claim upon which it was found. This stone frequently changed hands, and was finally purchased by a Bahia city exporter for £5,080, and was shipped to Paris, where it was broken up into marketable pieces.

The diamonds found in the Paraguacu are not so clear and perfect as those found about Cannavieras, but are said to have more brilliancy. They occur in conjunction with the carbons, and frequently contain small particles of uncrystallized carbon, which materially lessens their value. They are classified by the buyers at the mines into "bons," "fazenda," "fira," "melle," "vitriar," and "fundos." In the Cannavieras district diamonds were discovered in 1881. This region is reached from Cannavieras—on the coast south of Bahia city—by ascending the Prado River fifty-six miles in canoes to Jacarandá, and from there taking mules to Salobra, twelve miles higher up the same river. The diamonds are said to be found only in the river bed and the land directly adjacent thereto. It is impossible to state with definiteness the diamond and carbon output of the Bahia district, as no statistics are available, and not even the figures given for the exports can be taken as correct. There is an export tax of 13 per cent. and many stones must leave the country without paying duty, as the amount given as collected for diamonds and carbons is not equal to the carbon output alone, and all the carbons are exported. At the present time almost all of the diamonds are being exported uncut, as there is no local market for cut stones, and the work is not sufficiently well done to make them salable abroad. In the diamond regions there are several factories, and one is also situated in Bahia city.—Journal of the Society of Arts.

A NEW GLASS OF LOW SOLUBILITY.*

By G. E. Barton.

The statement in a recent number of Science † to the effect that American glass is inferior to that made in Germany is without doubt true if for "Germany" we read "Jena." The grounds for the claim that at least one glass made in this country heretofore has been equal to anything made on the Continent except Jena glass, I submit herewith. I have here, also, samples of a glass of my own devising which I believe is the equal of the Jena glass as regards its resistance to water, acids and carbonates, and superior in its resistance to caustic alkali solutions. Before presenting the figures, however, a brief résumé of the method by which they were obtained and the reason for its choice in preference to others is submitted.

In deciding upon this method for testing the comparative solubility of different glasses, I have passed over the beautiful work of Pfeiffer, Kohlrausch, Mylius and Foerster, all of whom have compared different glasses by determining the amount of bases which go into solution upon treating them with water, either by conductivity or purely chemical methods, for a method which is not particularly novel, but gives results in the ordinary units of the chemist.

The method employed was as follows: Pint, globe, flat-bottomed flasks were rinsed in chemically pure ammonium hydroxide, then in water, then in chemically pure hydrochloric acid, then in water, and finally with alcohol and ether, after which they were dried at the temperature of the room by a current of dry air, carefully wiped with a towel, and allowed to stand exactly one-half hour before weighing. The weighing was carried to 0.1 mg. with the ordinary precautions of analytical chemistry. I am aware that the glass could not have been free from water at the time of weighing, but every effort was made to insure as uniform a state as regards moisture as possible.

The flasks after weighing were partially filled with exactly 300 c.c. of a 1 per cent solution of sodium carbonate, attached to an inverted condenser by a rubber stopper, and boiled for exactly three hours over an asbestos plate one-sixteenth inch thick heated by a Bunsen burner, the latter being so regulated as to produce as slow but constant an ebullition as possible. The level of the liquid was not appreciably lowered in the three hours. At the end of this time the flasks were disconnected, emptied, rinsed with water three times, then treated precisely as before the boiling, and weighed. 300 c.c. of water were next used, then 300 c.c. of a solution containing 0.4 per cent of hydrochloric acid, and finally the same quantity of a 1 per cent solution of sodium hydroxide, the weighing, rinsing and drying always being carried out as above described.

That this method gives results sufficiently accurate for factory control I have proved repeatedly. It has the great advantage that it can be applied by any one in almost any laboratory, as it only requires the ordinary forms of apparatus and reagents, and if used for comparing two samples of glass, no particular care as to the exact strength of the solutions used is necessary, provided only both are treated alike. The greatest cause of variation in testing the ordinary quality of chemical ware is that the surface layer of the glass, after partial extraction with the solvent, is more or less completely removed by the mechanical action of the escaping steam. This cause of variation becomes almost nothing, however, in testing glasses like the Jena normal glass and the new glass.

Mylius and Foerster* found that the ratio of the bases to silicic acid in the aqueous solution obtained by boiling water five hours in flasks, varied from 1:0.21 to 1:1.6, the figures being for a poor glass from Thuringia and Kavalier's glass respectively. From this it is plain that no conclusions as to the total amounts going into solution can be drawn with safety from the results of any method which only gives the amount of bases taken up. It is also clear that such a method cannot be used for comparing glasses so totally different in composition as those made by Schott at Jena and by Kavalier in Bohemia. While the unavoidable variations (when testing by the method I used) between different results with the same glass are sometimes rather large, it is also certain that they are equally great in using the ware, so that an average of a sufficient number of results comes nearer representing actual practice than anything else that has been proposed.

Each of the following figures is an average of three results and represents the loss in milligrammes sustained by flasks when tested as described:

LOSS PER FLASK EXPRESSED IN MILLIGRAMMES.

	White*, Tatu Co.	Kavalier.	Jena.	New glass.
One per cent sodium carbonate solution	134.4	126.6	30.6	32.3
Water	8.4	20.6	1.1	0.7
Two-fifths per cent hydrochloric acid solution	4 7	16.2	1.3	1.5
One per cent sodium hydroxide solution	100.1	78.4	97.1	89.0
Total loss	247.6	241.8	130.1	123.5

The variations between the new glass and the Jena glass are, with the exception of the solubility in 1 per cent sodium hydroxide solution, within the limits of factory practice. In resisting caustic soda solution, however, the new glass is undoubtedly superior to the Jena glass.

It may not be out of place at this time to call attention to the fact that beakers made of either the new glass or Jena glass can be used for evaporations on the water-bath without danger of cracking. A few tests of beakers made from other kinds of glass will convince one that very few pieces will stand exposure to steam for more than fifty hours. I have exposed beakers of both the new and Jena glass to the action of steam for over 200 hours continuously, without any sign of fracture appearing.

* Read at the Pittsburg meeting of the American Chemical Society, July 3, 1902.

† "It is claimed that American glass is inferior to German in quality and power of resistance to chemicals." Excerpt from the Report of the Census Committee of the American Chemical Society, Science 15, 813.

* Ztschr. anal. Chem. 31, 245.

THE CAY-CAY, OR INDO-CHINESE WAX TREE.

The forests of Indo-China teem with vegetable genera whose fruit and seeds contain oleaginous matter susceptible of being turned to advantage in the arts and economics of life. One of the most beautiful trees in these vast forests is known by the natives as the cay-cay, a description of which is given by M. Brousmiche in the Bulletin de la Société des Etudes Indo-Chinoises de Saigon.

The cay-cay is widely distributed in the forests of Cochin-China, and is found throughout Cambodia and Anam. It grows to a large size, frequently attaining a height of forty meters (about 130 feet) with a diameter of trunk of 1.20 meters (four feet.) The latter is straight and clean, and terminates in a bushy head of deep green foliage. The wood is exceedingly hard, of a very fine and compact grain, difficult to work, but susceptible of an exquisite polish. The bark is bitter, and rich in tannic principles. It flowers at the end of the dry season, the fruit ripening in July. The latter consists of drupes of the size of an ordinary plum, with fibrous mesocarp and ligneous endocarp, and inclose an oily kernel. Monkeys and wild hogs devour it with avidity. M. Brousmiche, and also M. de Lenessan, place the tree in the family of *Rutaceæ*, under the name *Irvingia Harmandiana*.

When the fruit ripens the Anamese repair to the forests and pick them up as they fall from the trees, and pile them up on the ground. When the fibrous mesocarp is destroyed, by process of decay, the nut is carried to the villages and then placed in the sun to dry. The kernels, which shrivel somewhat under this process, are extracted, and are bruised in wood or stone mortars and made into a paste. This latter, heated and submitted to powerful pressure, gives up its fatty principle, which runs out in liquid form, but solidifies upon cooling. In its solid form the product is known in Cochin-China as cay-cay wax.

The crude method of treatment just described yields an amount of wax equal to 20 per cent of the weight of the kernels treated, but when the latter are extracted by means of carbon disulphide the yield is 52 per cent (Vignoli).

When the fruit is gathered as soon as ripe (not waiting for windfalls), and the kernels immediately submitted to pressure in properly constructed oil presses, the yield is much larger than by the native method; beside which the residue forms an oil cake of great value as a fertilizer, and as food for domestic animals. It is eagerly eaten by quadrupeds and fowls.

In commerce among the natives the cay-cay wax is found in conical masses weighing from four to six pounds. When freshly made it is grayish yellow in color, but bleaches on exposure to the air. It commences to melt at 38 deg. C. (100 deg. F.) and solidifies at 95 deg. F.; is almost insoluble in cold alcohol of 90 deg., but dissolves completely in boiling alcohol. It is very soluble in ether, carbon sulphide, benzol, and benzin. It yields acroleine on dry distillation. By saponification, M. Vignoli determined that it contained 70 per cent of fatty acids, of which oleic acid is most prominent, existing to the amount of 30 per cent. Glycerin is one of the products of saponification.

In Cochin-China there is a cay-cay butter, of which but little is known, and the use of which is very restricted. In Cambodia, the material is used for making candles, for which it seems well fitted, as the tapers burn with a bright light and give out no odor.

OLD-TIME REMEDIES FOR SNAKE BITE.

The subject of snake bite may occasionally engage the individual practitioner in a moorland countryside where, especially in the summer and autumn, cases are not unknown of infants dying from collapse after being bitten by vipers. We have recently been informed that the "infallible remedy" used by "Brusher" Mills, the well-known New Forest snake catcher, for the bite of the adder or viper is the fat of the creature itself melted, bottled, and applied, a drop at a time, to the wound. The cure, he asserts, is an affair of two minutes. Mills has, of course, had immense experience with snakes, having in his day killed or taken more than 4,000 venomous and 27,000 harmless specimens. He has, in fact, practically devastated his own field of operations round Lyndhurst. His belief in his remedy is shared by Wiltshire and Hampshire rustics and is doubtless universal in the country districts of England.

The question is whether this treatment is merely a survival of the old savage homœopathy which ordains a hair of the dog that bit you as a cure for the bite, or whether it is a rude form of serumtherapy. Vipers are exceedingly quarrelsome from the moment they break the egg, and unless immune against venom would long ago have ceased to exist as a distinct species. Hence their fat may be a kind of antitoxin. Of course, all fatty and oily substances are useful against poisons, which they doubtless absorb and isolate. The old-fashioned "London viper catchers," mentioned by White of Selborne and others always employed hot olive oil as a cure or treatment for snake bite, and this with ammonia continues to be recommended.

We read of the oil cure in works of natural history, but find no mention of the peasants' use of fat. How came it to be used in the first instance? Probably in accordance with the savage theory that fat, blood, sputum and so forth, contain the life principle or "soul" of men and animals and are therefore a cure for any lesion. Fat was anciently used to frighten away serpents from gardens and houses. The "suet of deer strewed up and down where they [adders] come will cause them to depart," says Agrippa of Nettesheim, whose ideas, despite his skepticism, were often those of the tribal medicine man. Bacon fat, mixed with the brains of a weasel, is recommended by him to scare away rats and mice.

Drugs and charms obtained from snakes are, of course, very ancient. The witches in "Macbeth" make a baleful viper broth, but the same mixture was also a medicine and cure for many diseases. The sloughs of snakes had also singular uses. The sixteenth century Jérome Cardan is quoted in an old chapbook as saying, "If any do sprinkle his head with the powder of a skin that a snake doth cast off, gotten or gathered when the moon is in the full, being also in the first part of Aries the Ram, he shall see terrible and fearful dreams. And if he shall have it under the sole of his foot he shall be acceptable before magistrates and princes."—London Lancet.

COBALT WEATHER BAROMETER.

Cobalt salts have the property of changing from blue to pink as they absorb moisture, so that in dry weather paper or fabrics dyed with a solution of chloride or nitrate of cobalt will acquire a blue tint, but as the atmosphere becomes damp the paper or fabric changes to a pink color. The same reaction is witnessed in writing done with the so-called "sympathetic ink" made from a solution of chloride of cobalt. A writing of this salt is almost colorless, and writing traced with it is invisible on white paper. But if the paper be warmed the compound gives up water which it has been holding in chemical combination, the deep blue anhydrous chloride of cobalt is produced, and the writing is very plainly seen. The writing disappears again as the paper cools, because enough water is absorbed from the air to cause the re-formation of the colorless hydrated compound.

Here are some formulas for window pane barometers: (1) Chloride of cobalt 1, gelatine 10, water 100 parts. (2) Chloride of copper 1, gelatine 10, water 100 parts. (3) Chloride of cobalt 1, gelatine 20, water 200 parts; nickel oxide ¾, chloride of copper ¼ part. The variations of color will indicate the probable weather. In damp states of the atmosphere the glass will be almost colorless, but in dry weather No. 1 will assume a blue, No. 2 a yellow, and No. 3 a green tint.

A so-called "chemical weather glass" is made by pouring into a narrow glass phial or tube 8 or 10 inches in length and ½ to ¾ inch in diameter, a so-

lution made by dissolving 25 grains of ammonium chloride, 25 grains of crystallized potassium nitrate and 2 drachms of camphor in 2 ounces of proof spirit and closing the bottle or tube with a cork which has been perforated by a red-hot needle. The indications for this weather glass are: Fine, the liquid part will remain transparent, and the solids will collect at the bottom of the bottle. Rain, the solids will gradually rise, and small, star-shaped crystals will form and move about in the clear liquid. Twenty-four hours in advance, a storm or high wind will be indicated by the liquid becoming turbid, the solid portion rising to the surface. During the hot summer months, in fine weather, the solid portion remains at the bottom; in winter, during frost or snow, the solid particles keep in constant motion.—Pharm. Era.

IMPROVING ON NATURE.

For years the scientific gardener has been gathering apples from pear trees, and picking cherries and damsons off the same branches, and, though the quest of the black tulip has so far been in vain, the blue rose, we are told, has at last arrived at Kew Gardens. Years ago horticulturists were interested in the announcement that a nurseryman at Essy, in Slavonia, had secured a wild rose from Servia which was said to give blooms of a deep violet blue, and that, after two years of cultivation, the rose retained its color. But there is still an uncertainty whether the blue tint was natural or produced by chemical means, in the same way as another horticulturist is known to have produced a black rose. Most people will be content, no doubt, with the "red, red rose that sweetly blooms in June," and nobody will very much deplore the failure of the efforts to produce roses of black, or blue, or green or any other unnatural color.

More pardonable, perhaps, is the hobby of the man who would grow a universal fruit tree. Even this, of course, is contrary to all the laws of nature, and ought by natural law to be abolished. But there is a farmer in Herefordshire who insists, it is said, on gathering—not grapes from thistles, but pears and plums and apples from cherry trees. Many years ago the enterprising farmer grafted these alien fruits on to his cherry tree, and by careful cultivation the four branches have been brought to full fruition. Many of the visitors to Naples have seen a famous tree there on which oranges and lemons grow side by side.—St. James's Gazette.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Motor-Cycle Trade in Great Britain.—The motor-cycle trade in the United Kingdom is a matter of practically only two years' growth; but it promises to become a most important branch of the automobile business, and—possibly in even a greater degree than the motor car—to help in solving the housing problem in England. That feature, interesting though it is, belongs more to the domain of social science; but the fact remains that there has just developed in this country a new branch of trade, catering not only to the very rich, but also to those who are merely well to do. In this new business, there is every reason that the American manufacturer should participate.

Although motor cycles are not yet nearly so numerous as the pedal-driven machines, there are already some thousands in use in the United Kingdom, and their appearance in London and on the country roads near all the larger towns is now so common as to no longer excite comment. The new sport has already a special journal devoted to its interests.

While there is, popularly speaking, a boom in motor cycling and there are over a score of machines on the market, the majority is of French or Belgian make, and a number that are advertised as English machines, with English names, are either imported outright or consist of continental motors built into English frames by local companies. There are probably half a dozen machines that are really English built throughout, and of these only three—the Singer, the Enfield, and the Humber—are the product of big factories that have previously made a reputation in the cycle business, and have now turned their attention to motors, owing to the popular demand. America is already represented in the market by three standard machines, the Mitchell, the Orient, and the Royal, all of which, it may be said, compare favorably with the best English and continental makes. There is still room, however, for the American manufacturer who will cater to the demands of the English rider.

Belt-driven machines are still vastly in the majority, despite certain obvious disadvantages of the system; though, curiously enough, among the high-grade English machines the Singer is gear-driven, and the Humber has a chain drive with a spring clutch for taking up the starting strain of the motor. The high-tension electric ignition system, with coils and accumulators, is universal, though the Singer has an electro-magnetic ignition device which works very satisfactorily.

Excessive weight is the most objectionable feature of the prevailing type of machine. Those most commonly seen average 100 pounds. One of the standard road machines weighs 120 pounds, while the track racers, though they hardly deserve to be classed with the popular motor cycle, reach as much as 250 or 300 pounds. The lightest practical road machine is the Clement-Garrard, a French product. The motor set complete weighs only 21 pounds, and is built into an English frame by a company in Birmingham, the machine scaling 65 pounds, all on.

Speaking on the weight question, the editor of Motor Cycling said recently:

"The featherweight machine is the next improvement that the public will demand from the manufacturer. People who now pay 40 guineas for a machine weighing 100 pounds or more would willingly pay 50 or 60 guineas for one weighing only half as much."

The principal difference between the English and American machines at present is that the English are belt-driven instead of chain-driven or direct geared. The motor is frequently merely clamped into the diamond frame of an ordinary bicycle instead of being built into a special frame. It is only fair to say, however, that a number of special frames are now being designed with a special view to standing up under the increased weight and vibration of the motor. Accumulators are favored as against dry batteries or electro-magnetic ignition. The standard horse power up to date has been 1½, but new machines are being constantly turned out with engines of from 1¾ to 2½ horse power, to meet the demand for greater hill-climbing power. It is generally conceded that the very high-powered wheels are wasteful of fuel and subject to excessive vibration on the level, and that the ideal machine will be one with a light and comparatively low-powered motor, but with a two-speed gear that will insure good hill-climbing power.

In spite of the English speed limit of 12 miles per hour, the English motor cyclist demands a machine capable of a good 20 miles on the level, with ability to keep it up without danger of overheating. It may be remarked that English roads are much better than the average in America, so that the machine which will endure hard work in the United States may be assumed to be perfectly capable of meeting English requirements.

It must be borne in mind, however, that the English purchaser, while he is able and willing to pay, demands first-class material and workmanship for his money, and the surest way to spoil a promising market is to try to tempt him with anything less than the best, either on the score of cheapness or attractive appearance. Unfortunately, it is a matter of history that the English market for American bicycles was ruined in just this fashion, when it promised to develop into an important field. True, there are one or two standard makes of American wheels that are still recognized here as models of excellence, but the work of other American firms, in throwing a lot of cheap low-grade wheels on the English market, ruined the reputation of our bicycle, so that both dealers and riders now refer to American wheels as "Yankee trash" in the most matter-of-fact way, and it is hard to persuade them that we can and do produce wheels of any other sort.

Of course, in its present stage of development, the motor cycle is undergoing constant change and improvement. There is no machine on the market that can claim to combine all the desirable features. But there are several points that might well be kept in view by a maker who wants to produce an ideal wheel for the English trade. Weight should be maintained as low as is consistent with effective working. A 50-pound wheel at the present juncture would command practically its own price. A thoroughly effective chain or gear drive, obviating the constant belt troubles that now worry the rider, would soon make its way, in spite of the popular idea fostered by many makers that the belt drive is the only effective and practical form of transmission. A simple two-speed gear, giving 20 miles an hour on the level, with the ability to take grades of one in seven without pedal assistance, is in great demand and is not forthcoming. A light weight but reliable form of electro-magnetic ignition would win its way against the now popular accumulator system. The trouble with the present magneto systems is that they will not endure the constant vibration. Ample mud guards are always demanded, preferably with an overhang beyond the front fork. English road riders have to contend with a large percentage of rainy weather, and they will cheerfully face rain for the sake of a ride, so that good mud guards are essential. The petrol capacity of the machine should be at least 100 miles. Single-lever control of the gas and electric-sparking devices has been tried, and proved both effective and popular. Antivibration seat posts and handle bars are absolutely essential to comfort, and while there are good devices of this sort on the market, I believe there is at present no machine turned out from the factory with them. Another feature strongly demanded by riders, and not yet supplied, is either a comfortable spring foot rest or a swing-back pedal that will do away with the cramped position incident to keeping the feet on fixed pedals during a long ride.—H. Clay Evans, Consul-General at London.

Packing Postal Parcels for Honduras.—Consul W. E. Alger reports from Puerto Cortez, October 22, 1902:

I give below a translation of a notice appearing in the newspapers of Honduras:

"In order to avoid damages and also claims, interested parties are asked to advise their correspondents abroad to be more careful in the packing of postal parcels, as the greater part of the time they arrive in bad condition, with the contents soiled and deteriorated. It would be wise to pack such parcels in cloth, well sewed, or in oiled or impermeable paper. . . . Signed, Director-General of Post Offices."

I would add that, of my personal knowledge, postal parcels from England, France and Germany arrive here in perfect condition, only those coming from the United States being improperly packed.

Index to Advance Sheets of Consular Reports.

The Reports marked with an asterisk (*) will be published in the Scientific American Supplement. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Cooling Cream—

Quince seed	1 ounce
Boric acid	16 grains
Starch	1 ounce
Glycerin	16 ounces
Carbolic acid	30 minims
Alcohol	12 ounces
Oil of lavender	30 minims
Oil of rose	10 drops
Extract of white rose	1 ounce
Water, enough to make	64 ounces

Dissolve the boric acid in a quart of water and in this solution macerate the quince seed for three hours, then strain. Heat together the starch and the glycerin until the starch granules are broken, and mix with this the carbolic acid. Dissolve the oils and the extract of rose in the alcohol, and add to the quince-seed mucilage; then mix all together, strain, and add water enough to make the product weigh sixty-four ounces.—Pharm. Era.

Fixing Agents in Perfumes.—Every one familiar with the compounding of perfumes knows that where a given odorous substance is very volatile something less volatile is mixed with it, to "fix" it as it is commonly said. This may delay the evaporation of the more volatile; at all events, something odorous remains and the perfume has the credit of permanence. In the paper on "Colognes and Toilet Waters," presented by Prof. Scoville at the Philadelphia meeting of the American Pharmaceutical Association, the author discusses especially the use of fixatives. He says: "The secret of perfumery lies mainly in the choice of the fixing agents—i. e., those bodies which intensify and hold the floral odors. The agents formerly employed were musk, civet and ambergris, all having a heavy and dull animal odor, which is the direct antithesis of a floral fragrance. A free use of these bodies must inevitably mean a perfume which requires a label to tell what it is intended for, to say nothing of what it is. Such was the perfume of a dozen years ago. To-day there is no evidence that the last of these (ambergris) is being used at all in the newer perfumes, and the other two are employed very sparingly if at all. The result is that the newer perfumes possess a fragrance and a fidelity to the flowers that they imitate which is far superior to the older perfumes. Yet the newer perfume is quite as prominent and lasting as the old, while it is more pleasing. It contains the synthetic odors, with balsams or resinous bodies as fixatives, and employs musk and civet only in the most sparing manner in some of the more sensitive odors." As a fixing agent the author especially commends benzoin. Only the best variety, he says, should be used, the Siam, which costs five or six times as much as the Sumatra. The latter has a coarse pungent odor.

Benzoin has heretofore been used but sparingly, and generally if not always with musk, etc., and we are pleased to hear that it proves serviceable alone, for there is certainly something unpleasant in the idea of the use of musk, ambergris and civet, when one thinks of their source.

The practice of using musk in colognes and toilet waters still widely prevails we are told. This the author thinks a mistake. "A cologne," he says, "should be refreshing and invigorating. It has a positive therapeutic value in slow fevers, after surgical operations, etc., when it possesses these qualities. To the feverish patient, weary with the long lying in bed and tired of the smell of medicines, and in a room which seems stuffy, though it may not be, the application of a little muskless cologne to the face and hands is at once a bath and a change of atmosphere. Antipyretics may be more necessary in acute fevers, but they can never be so invigorating and cheering. But musk is depressing, and its use in cologne in even the minutest quantity will spoil the cologne for such uses. The first effects may be refreshing, but the musk lingers after the lighter odors have disappeared, and a sick person is pretty sure to feel its effects. Persons in vigorous health will not notice the depressing effects of musk, but when lassitude prevails these are very unpleasant. Moreover it is not a necessity in these toilet accessories, either as a blending or as a fixing agent. Its place is better supplied by benzoin for both purposes."

We quite agree with the author in his position as to the nature and service of cologne, but go further as to "fixing." We agree with what we think was the practice of the ancient perfumers, namely to leave all fixing agents out of perfumes intended for free use at the toilet.

Prof. Scoville offers a formula for cologne water which he says closely resembles the popular "Farina" ones. It is as follows:

Oil of bergamot	1½ drachms
Oil of lemon	6 drachms
Oil of neroli	4 drachms
Oil of orange	2 drachms
Oil of rosemary	2 drachms
Tincture of benzoin	1 ounce
Orange flower water	12 ounces
Alcohol to make 1 gallon.	

The tincture of benzoin is to be the same strength as directed in the Pharmacopœia.

As to alcohol, Prof. Scoville thinks a lot of nonsense has been written about the necessity of extreme care in selecting it, "such as certain kinds requiring alcohol made from grapes and others demanding extreme purification, etc. A reasonable attention to a good quality of alcohol, even at a slight increase in cost, will always pay, but, other things being equal, a good quality of oils in a poor quality of alcohol will give far better satisfaction than the opposite combination. The unsophisticated public is not composed of exacting connoisseurs, and it does not appreciate extreme care or expense in either particular. A good grade of pharmaceutical alcohol, reasonably free from heavy and lingering foreign odors, will answer practically all the requirements.

While there is no doubt that the "cologne spirits" of modern times will fill most requirements one must remember that alcohol obtained from grapes is quite

different as to its incidental constituents from grain alcohol. These constituents Piesse declared to be needful to produce the finest cologne water, but however he probably had no "deodorized" to experiment with in his day.

Prof. Scoville further says:

Distillation of colognes and toilet waters, so often directed, is another delusion. It is true that heat will hasten the blending of the oils and the ripening of the perfume, but it will be far better and easier secured by a gentle digestion than by distillation. In fact, distillation of these, he says, is more likely to work harm than good.—Drug. Cir. and Chem. Gaz.

TRADE NOTES AND RECIPES.

About the Quickest Cleaner that we can recommend to clean brass scale pans is a solution of potassium bichromate in dilute sulphuric acid, using about 1 part of chromate, in powder, to 3 parts of acid, and 6 parts of water. In this imbibe a cloth wrapped around a stick (to protect the hands), and with it rub the pans. Best do this at tap or hydrant, so that no time is lost in placing the pan in running water after having rubbed it with the acid solution. For pans not very badly soiled rubbing with ammonia water and rinsing is sufficient.—National Druggist.

To Restore Faded Writing.—As a usual thing, ammonium sulphide in aqueous solution will restore faded documents, originally written in ordinary commercial ink with iron as a basis. Inks with other bases require treatment varying according to their nature. If we could see a specimen of the writing we would be better qualified to advise. Try ammonium sulphide, however, as the greater part of the inks used in commercial correspondence are of the iron and nutgall sort.—National Druggist.

Quick-Drying Floor Dressing.—

Shellac	100 parts
Alcohol	200-250 parts
Balsam copaiba or Venice turpentine	1-2 parts

Mix, and dissolve. Color, if desired, with ocher or umber. The addition of the half of 1 per cent. of boiled linseed oil adds great elasticity and strength to the mixture—so says the Werkstatt.—Nat. Drug.

To Make Solid Loose Nails in Walls.—The Drogisten Zeitung says: As soon as a nail driven in the wall gets loose and the plastering begins to break loose around it, it can be made solid and firm by the following process: Saturate a bit of wadding with thick dextrin or glue, wrap as much of it around the nail as possible and reinsert the latter in the hole, pressing it home as strongly as possible. Remove the excess of glue or dextrin, wiping it cleanly off with a rag dipped in clean water, then let dry. The nail will then be firmly fastened in place. To this we would add that if the loose plastering be touched with the glue and replaced, it will adhere and remain firm.—Nat. Drug.

Unfermented Wine or Grape Juice.—Pick the grapes from the stems and mash them. Strain the juice into a kettle, boil it, remove the scum, strain it into bottles or jars and seal. Bottles are better than jars; they should be tightly corked and have sealing wax above the cork. If only a small quantity of juice is to be used at one time, small bottles will be more convenient than large ones. But the juice will keep several days after being opened in ordinary winter weather. Lay the bottles on their sides in a cool, dark place. It will do no harm to strain the juice when the bottles are opened. Don't use sugar; it is unnecessary, and there is some danger of making grape jelly instead of juice. Thus made grape juice will keep for years.—Pharm. Era.

To Attach Leather or Cardboard.—To attach leather to cardboard dissolve good glue (softened by swelling in water) with a little turpentine and a sufficiency of water in an ordinary glue pot, and then having made a thick paste with starch in the proportion of two parts, by weight, of starch powder for every one part, by weight, of dry glue, mix the compounds and allow the mixture to become cold before application to the cardboard.—Pharm. Era.

Blue Marking Ink.—A solid blue ink, or marking-paste, to be used with a brush for stenciling, is made as follows: Shellac, 2 ounces; borax, 2 ounces; water, 25 ounces; gum arabic, 2 ounces; and ultramarine sufficient. Boil the borax and shellac in some of the water till they are dissolved, and withdraw from the fire. When the solution has become cold, add the rest of the 25 ounces of water, and the ultramarine. When it is to be used with the stencil, it must be made thicker than when it is to be applied with a marking-brush.—Pharm. Era.

Removal of Corns.—The liquid used by chiropodists with pumice stone for the removal of corns and callosities is usually nothing more than a solution of potassa or concentrated lye, the pumice stone being dipped into the solution by the operator just previous to using.—Pharm. Era.

Testing Milk with Litmus.—H. D. Richmond (Chem. News) reports that litmus paper is entirely useless for testing the acidity of milk, this material often giving a reaction with perfectly fresh milk. Litmus paper may be either red, containing only the acid; or blue, containing besides the acid a varying amount of alkali, so that the paper may contain either all red particles of litmus, all blue, or an intermediate mixture of the two. If these varieties of paper are applied to partially neutralized acids of various strength contradictory results may be obtained. Milk contains phosphoric acid in several states of neutralization. If milk is tested with a blue litmus, the paper having its acid entirely neutralized is more alkaline than the milk, and a portion of the alkali will pass into the liquid until equilibrium is restored; in consequence, the litmus becomes less alkaline and turns slightly red. If red litmus paper, which is more acid than the milk, is employed, alkali will pass from the liquid to the paper and turn it slightly blue. Litmus paper of some intermediate stage would not be affected.

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